and the main lake at the junction of Lake Hazen and Ruggles River I discovered the remains of permanent Esquimaux huts. Many relics were obtained at that place and at various points along the southern shore of Lake Hazen, but no traces of any kind were found on the northern shore of the lake. It is perhaps worthy of remark that reindeer, which must have been plentiful in that country, have entirely disappeared, having either migrated or become extinct. In connection with the line of perpetual snow I may state that on Mount Arthur it was not far from 3500 feet above the sea. From barometrical measurements it appeared that the crest of Grinnell Land was above 2500 feet elevation in front of the southern ice-cap, 3000 feet near Mount Arthur.

THE BRITISH ASSOCIATION

SO far as reports have reached us, the Montreal meeting has been a brilliant success, at least from the social point of view. The enthusiasm of the reception by the Canadians could not have been greater, and that enthusiasm, we are glad to notice, has met with a cordial response from the 800 members of the Association who went to Montreal. From the ample reports in the *Times* it is evident that, notwithstanding the many outside attractions devised by the hosts of the Association, the work in the Sections has in quantity and quality been up to the average. The proceedings began on Tuesday week with an address from the Mayor and Corporation of Montreal, and on Wednesday the Governor-General, Lord Lansdowne, welcomed the Association in a warm speech, in which the right keynote was struck. "If," he said, "you selected within the British Colonial Empire a spot for your meeting, you could not have selected a colony which better deserved this distinction either in respect of warmth of affection for the mother country, or the desire of its inhabitants for the diffusion of knowledge and culture. In a young country such pursuits are conducted in the face of difficulties, competition with material activity necessarily absorbing the attention of a rapidly developing community. We may claim for Canada that she has done her best, and has spared no pains to provide for the interests of science in the future. She has scientific workers known and respected far beyond the bounds of their own nation." Lord Lansdowne spoke warmly of the honour conferred upon Principal Sir John Dawson, who is more responsible than any other single person for the Association's visit. "We regard," he said, "the knighthood Her Majesty has bestowed upon him as an appropriate recognition of his distinguished services, and an opportune compliment to Canadian science. But the significance of this meeting is far greater than if measured merely by the addition it will make to the Empire's scientific wealth. When we find a society which for fifty years has not met outside the British Islands transferring its operations to the Dominion; when we see several hundred of the best-known Englishmen arriving here, mingling with our citizens and dispersing over this continent; when we see in Montreal the bearers of such names as Rayleigh, Playfair, Frankland, Sanderson, Thomson, Roscoe, Blanford, Moseley, Lefroy, Temple, Bramwell, Tylor, Galton, Harcourt, and Bonney, we feel one more step has been taken towards the establishment of that closer intimacy between the mother country and her offspring which both here and at home all good citizens of the Empire are determined to promote."

In introducing Lord Rayleigh as President, Sir William Thomson said:—

"It would have been a well-earned pleasure for my friend Prof. Cayley had he been able to visit Montreal, to introduce Lord Rayleigh to-night as his successor in the office of President of the British Association. Prof. Cayley has devoted his life to the advancement of pure mathematics, and it is peculiarly appropriate that he should be followed in his honourable post by one who has made the brilliant applications of mathematical power to the discovery and illustration of natural phenomena with which Lord Rayleigh has enriched physical science. Lord Rayleigh's optical researches are of great value—notably his profound and searching mathematical investigation of the blue sky and the polarisation of light by reflection. His book on 'Sound' is the greatest and most important work which has yet appeared on the subject. His determination of the ohm, which constitutes the accurate foundation for the great modern science of electrical measurement, is of supreme importance not only in the scientific laboratory but in all practical applications of electricity, as in the telegraph cable factory and the signalling station, in electrical engineering works, in every practical application of electric light, electro-metallurgy, and the electrical transmission of power. With much pleasure I resign the chair for Prof. Cayley, and introduce Lord Rayleigh as President of the British Association."

The Royal Society of Canada presented an address of welcome to the Association, and the American Association sent a cordial invitation to the members to attend the meeting at Philadelphia. Over 200 were to go, leaving Montreal by special train this morning.

A brilliant reception was given on Thursday night by the Governors, Principal, and Professors of McGill University, and Saturday was devoted entirely to excursions. Prof. Lodge's lecture on "Dust" on Friday night was both scientific and practical, and appears to have been a great success. He did well to speak strongly to a practical people of the rewards of pure scientific research, though we trust that one result of the meeting will be to open the eyes of the Canadians to the utility of substantially encouraging such research.

One of the most notable incidents of the meeting seems to have been the reception given to Prof. Asa Gray in the Biological Section, where he read a paper on North American botany, one of the most remarkable papers, Prof. Moseley stated, ever read in that Section. When Prof. Gray rose to reply, he received a perfect ovation.

The Corporation of McGill University, in commemoration of the British Association meeting at Montreal, were to confer, at the closing meeting yesterday, the honorary degree of LL.D. upon the following prominent representatives of science:—The President, Lord Rayleigh; the following Vice-Presidents: the Governor-General, Lord Lansdowne; Sir John A. Macdonald, Sir Lyon Playfair, and Prof. Frankland; the General Secretaries, Capt. Douglas Galton and Mr. A. G. Vernon Harcourt; the Secretary, Prof. Bonney; the Sectional Presidents, Sir William Thomson, Sir Henry Roscoe, Mr. W. T. Blanford, Prof. Moseley, General Sir J. H. Lefroy, Sir Richard Temple, Sir Frederick Bramwell, and Dr. E. B. Tylor; also upon Prof. Daniel Wilson, President of Toronto University and the leading Canadian archæologist; Prof. Asa Gray of Harvard, the leading American botanist; and Prof. James Hall, the State Geologist of New York.

Lieut. Greely made his appearance in the Geographical Section on Tuesday, and gave a detailed account of the geographical and scientific results of his recent Arctic expedition. His paper, however, was no mere sensation; what he told the meeting of the condition of Grinnell Land is of real scientific value. On another page will be found the report of Lieut. Greely's paper.

One practical result of the Montreal meeting is that the Association will offer a gold medal in the Department of Applied Science in McGill University as a memento of the visit. Moreover, Mr. Blanford proposed in the Geological Section that as some return for the way in which they had been received the members should contribute for the formation of science scholarships in McGill College.

SECTION C

GEOLOGY

Opening Address by W. T. Blanford, F.R.S., Sec.G.S., F.R.G.S., President of the Section

In commencing an address to the Geological Section of the British Association on the first occasion on which that body has met outside of the British Islands I feel much difficulty. Amongst the eminent geologists who have filled the post which you have done me the honour of calling upon me to occupy for the present year there are several who would have been able, from their knowledge of both European and American geology, to treat with authority of the many points of interest elicited by comparison of geological phenomena on opposite sides of the Atlantic Ocean. My own experience has been chiefly derived from the distant continent of Asia, and I have not that intimate acquaintance with the geology of Europe, nor that knowledge of the progress of geological research in America, which would justify my entering upon any comparison of the two continents. It has, however, occurred to me that, amongst the questions of wide importance connected with the correlation of strata in distant parts of the world, there is one to which some interesting contributions have been made by the work of the Geological Survey of India, and by the geologists of Australia and South Africa, and that a short time might be profitably devoted to a consideration of a few remarkable exceptions to the rule that similarity of faunas and floras in fossiliferous formations throughout the surface of the world implies identity of geological age.

It has probably occurred to other geologists here present, as it has to myself, to be engaged in examining a country the geology of which was absolutely unknown, and to feel the satisfaction that attends the first discovery of a characteristic fossil form. A clue is at once afforded to the geology of the region; one horizon at least is believed to be determined, and from this horizon it is possible to work upwards and downwards until others are found.

It is, therefore, of especial importance to those engaged in geological exploration to satisfy themselves whether the conclusion is correct that identity, or close specific similarity, amongst fossil forms, is a proof that the beds containing them are of the same geological age. It has been pointed out by some of the most careful thinkers, and especially by Forbes and Huxley, that a species requires time to spread from one area to another, that, in numerous cases, a migratory specific form must flourish in the region to which it has migrated, after it has died out in its original birthplace; and that the presence of the same species in two deposits at distant localities may rather tend to indicate that both were not formed simultaneously. Huxley, as is well known, invented the term "homotaxis" to express the relations between such beds, and to avoid the possibly misleading expressions "geological synchronism," and "contemporaneous origin."

Despite such cautions, however, it still appears to be generally assumed by palæontologists that similarity between faunas and floras is evidence of their belonging to the same geological period; that the geological age of any formation, whether marine, fresh-water, or subaërial, can be determined by a comparison of its organic remains with those of other deposits, no matter how distant, of which the position in the geological sequence is ascertained: in short, that homotaxis of marine, fresh-water, and terrestrial forms implies geological synchronism.

That, as a general rule, homotaxis affords evidence that beds exhibiting it belong approximately to the same geological period appears supported by a large amount of evidence. But there are some startling exceptions. I propose to notice a few typical instances, several of them Indian, in which the system of determining the age of various formations by the fauna or flora has led to contradictory results, before attempting to show wherein the source of the error appears to lie. Nothing would be gained and much time would be lost by entering upon the details of all the cases known, even if I were able to give authentic particulars, which is doubtful. It will be sufficient to cite some characteristic examples, concerning the details of which satisfactory evidence is forthcoming.

Pikermi Beds.—There are but few fossiliferous deposits on the face of the earth that have attracted more attention than the Pikermi beds of Greece. In one of the most classical and famous sites of the world, a few miles east of Athens, just where

> The mountains look on Marathon,
> And Marathon looks on the sea,

some red, silty beds occur, abounding in vertebrate remains. Some of the bones were described by Wagner and others, but for a complete account of the fauna we are indebted to Prof. Albert Gaudry, who has himself collected by far the greater portion of the remains hitherto procured. The following is a list of the genera determined; it is unnecessary to give the specific names:—

MAMMALIA.

Primates.—*Mesopithecus*, 1 sp.
Carnivora.—*Simocyon*, 1; *Mustela*, 1; *Promephitis*, 1; *Ictitherium*, 3; *Hyæna*, 1; *Lepthyæna*, 1; *Hyænictis*, 1; *Felis*, 4; *Machærodus*, 1.
Proboscidea.—*Mastodon*, 2; *Dinotherium*, 1.
Ungulata.—*Chalicotherium*, 1; *Rhinoceros*, 3; *Acerotherium*, 1; *Leptodon*, 1; *Hipparion*, 1; *Sus*, 1; *Camelopardalis*, 1; *Helladotherium*, 1; *Orasius*, 1; *Palæotragus*, 1; *Palæoryx*, 2; *Tragocerus*, 2; *Palæoreas*, 1; *Antidorcas* (?), 1; *Gazella*, 1; *Antilope*, 3; *Dremotherium*, 2.
Rodentia.—*Hystrix*, 1.
Edentata.—*Ancylotherium*, 1.

AVES.

Phasianus, 1; *Gallus*, 1; *Gen. gallinac. indet.*, 1; *Grus*, 1; *Gen. ciconidar. indet.*, 1.

REPTILIA.

Testudo, 1; *Varanus*, 1.

Of Mammalia alone there are known from this deposit 31 genera, of which 22 are extinct, and 35 species.

Now, this fauna is almost invariably in European works quoted as Miocene. Of the species found no less than 14—*Simocyon diaphorus, Ictitherium robustum, I. hipparionum, Hyæna eximia, Hyænictis græca, Machærodus cultridens, Mastodon turicensis, Dinotherium giganteum, Rhinoceros schleiermacheri, Hipparion gracile, Sus erymanthius, Helladotherium duvernoyi, Tragocerus amaltheus*, and *Gazella brevicornis*—are met with in other European deposits assigned to the Miocene period. It is true that one of these deposits at least—that of Eppelsheim—has been shown on stratigraphical grounds to be much more probably Pliocene than Miocene, and the position of other deposits has been determined by the kind of argument which, as I shall show, has proved misleading in the case of Pikermi itself. Nevertheless so general is the consensus of opinion amongst palæontologists, that the beds with *Hipparion* at Pikermi and elsewhere are quoted as especially included in the Miocene system by the French Committee of the International Geological Congress. Amongst English writers the Miocene age of the Pikermi beds appears generally admitted, as by Mr. Wallace (*Geographical Distribution of Animals*, i. p. 115), Prof. Boyd Dawkins (*Q. J. G. S.* 1880, p. 389), Mr. E. T. Newton (*Q. J. G. S.* 1884, pp. 284, 287, &c.), and many others. Prof. Gaudry himself is much more cautious; he classes the fauna as intermediate between Pliocene and Miocene, and only relegates it to Upper Miocene because that is the position assigned by other palæontologists to beds containing remains of *Hipparion*. However, in his subsequent works Prof. Gaudry has classed the Pikermi fauna as Miocene.

Now, the lowest of the beds with the vertebrate fauna at Pikermi were by Prof. Gaudry himself found to be interstratified with a band of gray conglomerate containing four characteristic *marine* Pliocene Mollusca—*Pecten benedictus*, Lam.; *Spondylus gœderopus*, L.; *Ostrea lamellosa*, Brocchi; and *O. undata*, Lam. It should be remembered that the Pliocene fauna of the Mediterranean area is the richest and most typical in Europe, and is as well known as any geological fauna in the world. It should also be remembered that the Pliocene beds are well developed in Greece at other localities besides Pikermi. Prof. Gaudry especially points out that the vertebrate remains, supposed to be those of Miocene animals, are deposited in a stratum overlying a marine bed of undoubted Pliocene age, and he proposes the following hypothesis to account for the presence of Miocene fossils in a Pliocene stratum. The remains found at Pikermi are, he thinks, those of animals that inhabited the extensive plains which in Miocene times extended over a considerable proportion of the area now occupied by the Eastern Mediterranean, and which united Greece to Asia; the plains were broken up by the dislocations that took place at the close of the Miocene period, and the animals escaped to the mountains, where they died for want of space and of food. Their bones were subsequently washed down by the streams from the hills and buried in the Pliocene deposits of Pikermi.

Prof. Gaudry evidently has no very profound faith in this hypothesis, and it is unnecessary to refute it at length. One fact is sufficient to show that it is untenable. However sudden may have been the cataclysm that is supposed to have broken up the Miocene plains of Attica, a very long period, measured in years, must have elapsed before the Pliocene marine fauna could have established itself. Now, the bones of mammals exposed on the surface decay rapidly; the teeth break up, the bones become brittle. It is doubtful if bones that had been exposed for only five or six years would be washed down by a stream without being broken into fragments; the teeth especially would split to pieces. The condition of the Pikermi fossils proves, I think, that they must have been buried very soon after the animals died, that they were not exposed on the surface for any length of time, and that they could not have been washed out of an earlier formation, and it appears to me incredible that the Pikermi mammals were not contemporary with the Pliocene Mollusca that occur in the same beds. In short, I cannot but conclude that the Pikermi mammals were Pliocene and not Miocene.

This view is entirely in accordance with the opinions of Theodor Fuchs (*Denkschr. K. Acad. Wiss. Wien*, 1877, xxxvii. 2e Abth. p. 1). He has given a good account of the geology of various places in Greece, and amongst others of Pikermi. He found, again, the conglomerate with Pliocene marine Mollusca interstratified with the basal portion of the mammaliferous beds, and he concludes (*l.c.* p. 30), that not only is it clear that these mammaliferous beds are of Pliocene age, but that a comparison of their geological position with that of the marine strata of the Piræus proves that the Pikermi beds occupy a very high position in the Pliocene, and are probably the highest portion of the system as developed in the neighbourhood.

Fuchs also shows that the principal Pliocene mammaliferous beds are of later date than the typical Pliocene (sub-Apennine) beds of Italy, and that some Mammalia found associated with the latter comprise forms identical with those of the Pikermi beds. In subsequent papers on the age of the beds containing *Hipparion* the same writer shows reasons for classing these strata in Italy, France (Vaucluse), and Germany as intermediate between Miocene and Pliocene. This leaves the difficulty unsolved, for he had shown the Pikermi beds to be high in the Pliocene system. They rest unconformably upon certain fresh-water limestones, clays, &c., containing plants and Mollusca, and classed by Gaudry as Miocene, but by Fuchs as Pliocene. Thus by both writers mammaliferous beds of Pikermi are referred to a considerably later geological horizon than those containing identical species in other parts of Europe.

It would require too much time to enter into the still more difficult question of the various plant-bearing beds in different parts of Europe and in Greenland containing a flora classed by Heer and others as Miocene. Gardner has given reasons for considering the Greenland beds Eocene; Fuchs, as just stated, is of opinion that the Greek beds are Pliocene. One point should be noted, that the more nothern flora is considered older than the more southern, and it will be remarked that the same observation applies to the supposed Upper Miocene fauna of France and Germany and the Pikermi fauna of Greece.

Siwalik.—The next instance which I shall describe is another of the most important fossil mammalian faunas of the Old World, that found in the Upper Tertiary beds that fringe the Himalayas on the south. The name applied to this fauna is taken from one of the localities in which it was first found, the Siwalik (correctly, I believe, Shib-wâla) hills, between the Deyra Dun and the plains north by east of Delhi. Bones of Siwalik Mammalia are found, however, throughout a considerable area of the Northern Punjab.

The Siwalik fauna has been worked out, chiefly by Falconer and Lydekker, the last-named being still engaged in describing the species. The following is a list of the genera found in the true Siwalik beds:—[1]

MAMMALIA.

PRIMATES.—*Palæopithecus*, 1 sp.; *Macacus*, 2; *Semnopithecus*, 1; *Cynopithecus*, 2.

CARNIVORA.—*Mustela*, 1; *Mellivora*, 2; *Mellivorodon*, 1; *Lutra*, 3; *Hyænodon*, 1; *Ursus*, 1; *Hyænarctus*, 3; *Canis*, 2; *Viverra*, 2; *Hyæna*, 5; *Lepthyæna*, 1; *Æluropsis*, 1; *Ælurogale*, 1; *Felis*, 5; *Machærodus*, 2.

PROBOSCIDEA.—*Elephas*, 6 (*Euelephas*, 1; *Loxodon*, 1; *Stegodon*, 4); *Mastodon*, 5.

UNGULATA.—*Chalicotherium*, 1; *Rhinoceros*, 3; *Equus*, 1; *Hipparion*, 2; *Hippopotamus*, 1; *Tetraconodon*, 1; *Sus*, 5; *Hippohyus*, 1; *Sanitherium*, 1; *Merycopotamus*, 1; *Cervus*, 3; *Dorcatherium*, 2; *Tragulus*, 1; *Propalæomeryx*, 1; *Camelopardalis*, 1; *Helladotherium*, 1; *Hydaspitherium*, 2; *Sivatherium*, 1; *Alcephalus*, 1; *Gazella*, 1; *Antilope*, 2; *Oreas* (?), 1; *Palæoryx* (?), 1; *Portax*, 1; *Hemibos*, 3; *Leptobos*, 1; *Bubalus*, 2; *Bison*, 1; *Bos*, 3; *Bucapra*, 1; *Capra*, 2; *Ovis*, 1; *Camelus*, 1.

RODENTIA.—*Mus*, 1; *Rhyzomys*, 1; *Hystrix*, 1; *Lepus*, 1.

AVES.

Graculus, 1; *Pelecanus*, 2; *Megaloscelornis*, 1; *Argala*, 1; *Struthio*, 1; *Dromæus*, 1.

REPTILIA.

CROCODILIA.—*Crocodilus*, 1; *Gharialis*, 3.

LACERTILIA.—*Varanus*, 1.

CHELONIA.—*Colossochelys*, 1; *Testudo*, 1; *Bellia*, 2; *Damonia*, 1; *Emys*, 1; *Cautleya*, 1; *Pangshura*, 1; *Emyda*, 1; *Trionyx*, 1.

PISCES.

Bagarius, 1.

Now, until the last few years, this fauna was classed as Miocene by European palæontologists as unhesitatingly as the Pikermi fauna still is, and in the majority of European geological works, despite the unanimous opinion of all the geologists who are acquainted with the sub-Himalayan beds, the Siwalik fauna is still called Miocene. The geologists of the Indian Survey, however, class the fossiliferous Siwaliks as Pliocene, on both geological and biological grounds. With regard to the latter, not only does the fauna comprise a large number of existing genera of mammals, such as *Macacus*, *Semnopithecus*, *Ursus*, *Elephas* (*Euelephas*), *Equus*, *Hippopotamus*, *Camelopardalis*, *Bos*, *Hystrix*, *Mus*, and especially *Mellivora*, *Meles*, *Capra*, *Ovis*, *Camelus*, and *Rhizomys*, but three out of six or seven clearly-determined species of reptiles, viz.—*Crocodilus palustris*, *Gharialis gangeticus*, and *Pangshura tectum*—are living forms now inhabiting Northern India, whilst all the known land and fresh water Mollusca, with one possible exception, are recent species.

These data, however, although very important and very cogent, belong to a class of facts that have led, I believe, in other cases to erroneous conclusions. The geological evidence is far more satisfactory, and it is not liable to the same objection.

The whole Siwalik fauna, as given above, has been obtained from the upper beds of a great sequence or system. Beneath the fossiliferous strata at the base of the North-West Himalaya there is an immense thickness, amounting in places to many thousands of feet, of sandstones, clays, and other beds, from none of which recognisable fossils have been procured. The first beds of known age that are met with below the mammaliferous Siwaliks are marine rocks belonging to the Eocene system.

But as we pass from the Himalayas to the south-west, along the western frontier of India in the Punjab, and onwards to the south in Sind, the same Siwalik system can be traced almost without interruption, and in the last-named country the lower unfossiliferous strata become intercalated with fossiliferous beds. In Sind the upper Siwaliks no longer yield any vertebrate remains that can be identified, but far below the horizon of the Siwalik fauna a few bones have been found, and the following mammals have been identified (*Pal. Ind.* ser. x.; *Rec. Geol. Surv. Ind.* 1883, pp. 82, &c.)—

CARNIVORA.—*Amphicyon palæindicus.*

PROBOSCIDEA.—*Mastodon latidens, M. perimensis, M. falconeri, M. pandionis, M. angustidens, Dinotherium indicum, D. sindiense, D. pentepotamiæ.*

UNGULATA.—*Rhinoceros sivalensis*, var. *intermedius, Acerotherium perimense, A. blanfordi, Sus hysudricus, Hyotherium sindiense, Anthracotherium silistrense, A. hyopotamoides, Hyopotamus palæindicus, H. giganteus, Hemimeryx blanfordi Sivameryx sindiensis, Agriochœrus sp., Dorcatherium majus, D. minus.*

EDENTATA.—*Manis* (?) *sindiensis.*

Although about one-third of the species above named have been found also in the upper Siwalik beds of the Punjab, it is unnecessary to point out in detail why the lower Siwalik fauna is clearly by far the older of the two. The absence of such living genera as *Elephas*, *Bos*, *Equus*, &c., and the presence of

[1] Lydekker, *J. A. S. B.* 1880, pt. 2, p. 34; *Palæontologia Indica*, ser. x. vols. i. ii. iii.; *Records Geol. Surv. India*, 1883, p. 81. I am indebted to Mr. Lydekker for some unpublished additions.

so many typically Middle Tertiary forms, such as *Dinotherium*, *Anthracotherium*, and *Hyopotamus*, shows a great change. The Mollusca tell the same tale. All the forms known from the upper Siwaliks, with one exception, are recent species of land and fresh-water shells now living in the area. Of seven fresh-water Mollusca (*Mem. Geol. Surv. Ind.* vol. xx. pt. 2, p. 129) found associated with the lower Siwaliks none appears to be identical with any living species, and only two are allied, one closely, the other more remotely, to forms now met with in Burmah, 30° of longitude further east.

Before proceeding with the argument, it is as well to call attention to the very important fact just mentioned. It has been asserted over and over again that species of *Mammalia* are peculiarly short-lived, far more so than those of *Mollusca*. In this case, so far as the evidence extends at present, one-third of the species of *Mammalia* survived the changes that took place, whereas not a single mollusk is found both in the upper and lower Siwaliks. It should be remembered that the recent molluscan river fauna of this part of India is very poor in species, and that we probably know a considerable proportion of that existing in Siwalik times.

The geological age of the lower Siwalik beds of Sind is shown by their passing downwards into marine fossiliferous beds, known as the Gáj group, of Miocene age, the following being the section of Tertiary strata exposed in the hills west of the Indus :—

		Ft.	
Siwalik or Manchar	Upper	5000 unfossiliferous	Pliocene
	Lower	3000 to 5000 fossiliferous	Upper Miocene or Lower Pliocene
Gáj		1000 to 1500 fossiliferous	Miocene
Nari	Upper	4000 to 6000 unfossiliferous	Lower Miocene
	Lower	100 to 1500 fossiliferous	Oligocene
Khirthar	Upper	500 to 3000 fossiliferous	Eocene
	Lower	6000 fossiliferous	

Clearly the lower Siwaliks of Sind cannot be older than Upper Miocene ; therefore the upper Siwaliks, which are shown by both biological and geological evidence to be of much later date, must be Pliocene.

Gondwána System of India.—In the peninsula of India there is a remarkable deficiency of marine formations. Except in the neighbourhood of the coast or of the Indus Valley there is, with one exception (some Cretaceous rocks in the Nerbudda Valley), not a single marine deposit known south of the great Gangetic plain. But in Bengal and Central India, over extensive tracts of country, a great sequence of fresh-water beds, probably of fluviatile origin, is found, to which the name of Gondwána System has been applied. The uppermost beds of this system, in Cutch to the westward, and near the mouth of the Godávari to the eastward, are interstratified with marine beds containing fossils of the highest Jurassic (Portlandian and Tithonian) types.

The Gondwána system is a true system in the sense that all the series comprised are closely connected with each other by both biological and physical characters, but it represents in all probability a much longer period of geological time than do any of the typical European systems. The highest members, as already stated, are interstratified with marine beds containing uppermost Jurassic fossils. The age of the lowest members is less definitely determined, and has been by different writers classed in various series from Middle Carboniferous to Middle Jurassic. The Gondwána beds from top to bottom are of unusual interest on account of the extraordinary conflict of palæontological evidence that they present.

The subdivisions of the Gondwána system are numerous, and in the upper portions especially the series and stages are different in almost every tract where the rocks are found. The following are the subdivisions of most importance on account of their fauna and flora, or of their geological relations :—

Upper Gondwána	Cutch and Jabalpur Kota-Maleri Rájmahál	
Lower Gondwána	Panchet	
	Damuda	Rániganj and Kámthi Barákar
	Karharbári Tálchir	

The upper Gondwánas, where best developed, attain a thickness of 11,000 feet, and the lower of 13,000 ft.

The Tálchir and Barákar subdivisions are far more generally present than any of the others.

Tálchir.—The Tálchir beds consist of fine silty shales and fine soft sandstone. Very few fossils have been found in them, and these few recur almost without exception in the Karharbári stage. The Tálchirs are principally remarkable for the frequent occurrence of large boulders, chiefly of metamorphic rocks. These boulders are sometimes of large size, 6 feet or more across, 3 to 4 feet being a common diameter; all are rounded, and they are generally embedded in fine silt.

Karharbári.—The Karharbári beds are found in but few localities. They contain some coal-seams, and the following plants have been met with (Feistmantel, *Palæontologia Indica*, ser. xii. vol. iii.) :—

Coniferæ.—*Euryphyllum*, 1 sp. ; *Voltzia*, 1 ; *Albertia*, 1 ; *Samaropsis*, 1.
Cycadeaceæ.—*Glossozamites*, 1 ; *Noeggerathiopsis*, 1.
Filices.—*Neuropteris*, 1 ; *Glossopteris*, 4 ; *Gangamopteris*, 4 ; *Sagenopteris*, 1.
Equisetaceæ.—*Schizoneura*, 2 ; *Vertebraria*, 1.

The most abundant form is a *Gangamopteris*. The *Voltzia* (*V. heterophylla*) is a characteristic Lower Triassic (Bunter) form in Europe. The *Neuropteris* and *Albertia* are also nearly related to Lower Triassic forms. The species of *Gangamopteris*, *Glossopteris*, *Vertebraria*, and *Noeggerathiopsis* are allied to forms found in Australian strata.

Damuda.—The Damuda series consists of sandstones and shales with coal-beds ; the floras of the different subdivisions present but few differences, and the following is the list of plants found (*Pal. Ind.* ser. ii. xi. xii. vol. iii.) :—

Coniferæ.—*Rhipidopsis*, 1 sp. ; *Voltzia*, 1 ; *Samaropsis*, 1 ; *Cyclopitys*, 1.
Cycadeaceæ.—*Pterophyllum*, 2 ; *Anomozamites*, 1 ; *Noeggerathiopsis*, 3.
Filices.—*Sphenopteris*, 1 ; *Dicksonia*, 1 ; *Alethopteris*, 4 ; *Pecopteris*, 1 ; *Merianopteris*, 1 ; *Macrotæniopteris*, 2 ; *Palæovittaria*, 1 ; *Angiopteridium*, 2 ; *Glossopteris*, 19 ; *Gangamopteris*, 7 ; *Belemnopteris*, 1 ; *Anthrophyopsis*, 1 ; *Dictyopteridium*, 1 ; *Sigenopteris*, 4 ; *Actinopteris*, 1.
Equisetaceæ.—*Schizoneura*, 1 ; *Phyllotheca*, 3 ; *Trizygia*, 1 ; *Vertebraria*, 1.

The only remains of animals hitherto recorded are an *Estheria* and two Labyrinthodonts, *Brachyops laticeps* and an undescribed form formerly referred to *Archegosaurus*. The only European genus allied to *Brachyops* is of Oolitic age.

The most abundant of the above-named fossils are *Glossopteris* and *Vertebraria*. With the exception of *Noeggerathiopsis* all the cycads and conifers are of excessive rarity. More than one-half of the species known are ferns with simple undivided fronds and anastomosing venation.

For many years European palæontologists generally classed this flora as Jurassic.[1] This was the view accepted by De Zigno and Schimper, and, though with more hesitation, by Bunbury. The species of *Phyllotheca*, *Alethopteris* (or *Pecopteris*), and *Glossopteris* (allied to *Sagenopteris*) were considered to exhibit marked Jurassic affinities. It was generally admitted that the Damuda flora resembles that of the Australian Coal-Measures (to which I shall refer presently) more than it does that from any known European formation ; but the Australian plants were also classed as Jurassic. There is no reason for supposing that the more recent discoveries of Damuda plants would have modified this view ; the identification of such forms as true *Sagenopteris* and the cycads *Pterophyllum* and *Anomozamites* would assuredly have been held to confirm the Jurassic age of the beds. So far as European fossil plants are concerned, the Damuda flora resembles that of the Middle or Lower Jurassics more than any other.

One form, it is true, the *Schizoneura*, is closely allied to *S. paradoxa* from the Bunter or Lower Trias of Europe. Other plants have Rhætic affinities. But the connections with the Triassic flora do not seem nearly equal to those shown with Jurassic plants, and the reason that the Damuda flora has been classed as probably Triassic must be sought in the impossibility of considering it newer (Feistmantel, *Pal. Ind.* ser. xii. vol. iii. pp. 57, 129, &c.), if the next overlying stage is classed as Upper Trias or Rhætic, and in the close affinity with the underlying Karharbári beds, which contain several Lower Triassic types.

Panchet.—The uppermost series of the lower Gondwánas consists chiefly of sandstone, and fossils are rare. The most in-

[1] De Zigno, *Flora Fossilis Form. Ool.* pp. 50, 53 ; Schimper, *Traité de Paléontologie végétale*, i. p.645 ; Bunbury, *Q. J. G. S.* 1861, xvii. p. 350.

teresting are remains of *Reptilia* and *Amphibia*. The following is a list of the fossil animals and plants corrected to the present time :—

ANIMALS.

REPTILIA.

DINOSAURIA.—*Ancistrodon*, 1 sp.
DICYNODONTIA.—*Dicynodon* (*Ptychognathus*), 2.

AMPHIBIA.

LABYRINTHODONTIA.—*Gonioglyptus*, 2; *Glyptognathus*, 1; *Pachygonia*, 1.

CRUSTACEA.

Estheria, 1.

PLANTS.

CONIFERÆ.—*Samaropsis*, 1.
FILICES.—*Pecopteris*, 1; *Cyclopteris*, 1; *Thinnfeldia*, 1; *Oleandridium*, 1; *Glossopteris*, 3.
EQUISETACEÆ.—*Schizoneura*, 1.

The *Schizoneura* and the three species of *Glossopteris* are considered the same as Damuda forms. But with them are found two European Rhætic species, *Pecopteris concinna* and *Cyclopteris pachyrachis*. The *Oleandridium* is also closely allied to a European Rhætic form, and may be identical. The flora may thus be classed as typically Rhætic.

All the genera of *Labyrinthodonts* named are peculiar; their nearest European allies are chiefly Triassic. *Dicynodontia* are only known with certainty from India and South Africa, but some forms believed to be nearly allied have been described from the Ural mountains (Huxley, *Q. J. G. S.* xxvi. p. 48.). These fossils were obtained from rocks now referred to the Permian (Twelvetrees, *Q. J. G. S.* xxxviii. p. 500).

Upper Gondwánas.—The different series of the lower Gondwánas are found in the same area, resting one upon the other, so that the sequence is determined geologically. This is not the case with the upper Gondwána groups; their most fossiliferous representatives are found in different parts of the country, and the relations to each other are mainly inferred from palæobotanical data. Although, therefore, it is probable that the Rájmaháls are older than the Cutch and Jabalpur beds, and that the Kota-Maleri strata are of intermediate age, it is quite possible that two or more of these series may have been contemporaneously formed in regions with a different flora.

Rájmahál.—The comparatively rich flora of the lowest upper Gondwána series is contained in beds interstratified with basaltic lava-flows of the fissure-eruption type. The following are the genera (*Pal. Ind.* ser. ii.; Feistmantel, *Rec. G. S. I.* ix. p. 39) of plants found :—

CONIFERÆ.—*Palissya*, 2 sp.; *Cunninghamites*, 1; *Chirolepis*, 2; *Araucarites*, 1; *Echinostrobus*, 1.
CYCADEACEÆ.—*Pterophyllum*, 9; *Ptilophyllum*, 1; *Otozamites*, 3; *Zamites*, 1; *Dictyozamites*, 1; *Cycadites*, 2; *Williamsonia*, 2; *Cycadinocarpus*, 1.
FILICES.—*Eremopteris*, 2; *Davallioides*, 1; *Dicksonia*, 1; *Hymenophyllites*, 1; *Cyclopteris*, 1; *Thinnfeldia*, 1; *Gleichenia*, 1; *Alethopteris*, 1; *Asplenites*, 1; *Pecopteris*, 1; *Macrotæniopteris*, 4; *Angiopteridium*, 3; *Danæopsis*, 1; *Rhizomopteris*, 1.
EQUISETACEÆ.—*Equisetum*, 1.

The marked change from the lower Gondwána floras is visible at a glance; not a single species is common to both, most of the genera are distinct, and the difference is even greater when the commonest plants are compared. In the lower Gondwánas the prevalent forms are *Equisetaceæ* and ferns of the *Glossopteris* type, whilst in the Rájmahál flora cycads are by far more abundant than any other plants. The whole assemblage, moreover, is more nearly allied than are any of those in the lower Gondwána beds to European Mesozoic floras.

Of the Rájmahál plants (Feistmantel, *Pal. Ind.* ser. ii. pp. 143, 187; *Manual Geol. Ind.* p. 145) about fifteen are allied to Rhætic European forms, three to Liassic or Lower Jurassic (two of these having also Rhætic affinities), and six to Middle Jurassic (two having Rhætic relations as well. The flora must therefore as a whole on purely palæontological grounds be classed as Rhætic.

Kota-Maleri.—The deposits belonging to this series are found in the Godávari valley at a considerable distance from the Rájmahál hills in Bengal, the locality for the Rájmahál flora. Both Rájmahál and Kota-Maleri beds overlie rocks of the Damuda series. It is not quite clear whether the Kota beds, which contain fish, insects, and crustaceans, and the Maleri beds, in which remains of fish, reptiles, and plants are found, are interstratified, or whether the Kota beds overlie those of Maleri. That the two are closely connected is generally admitted.

From the Maleri beds the following remains have been collected :—

ANIMALS.

REPTILIA. *Hyperodapedon*, 1 sp.; *Parasuchus*, 1.
PISCES. *Ceratodus*, 3.

PLANTS.

CONIFERÆ.—*Palissya*, 2; *Chirolepis*, 1; *Araucarites*, 1.
CYCADEACEÆ.—*Ptilophyllum*, 1; *Cycadites*, 1.
FILICES.—*Angiopteridium*, 1.

From the Kota fresh-water limestone nine species of ganoid fish —viz. five of *Lepidotus*, three of *Tetragonolepis*, and one of *Dapedius* —have been described. An *Estheria*, a *Candona*, and some insects have also been found. The fish (*Pal. Ind.* ser. iv. pt. 2) are Liassic forms.

The Reptilia of the Maleri beds are, on the other hand, Triassic[1] and closely allied to Keuper forms. *Ceratodus* is chiefly Triassic (Keuper and Rhætic). The plants show relations with both the Rájmahál and Jabalpur floras, and, as the palæontological relations to beds in the same country are considered far higher in importance than those to deposits in distant regions, the Kota-Maleri beds are classed as intermediate between the Rájmahál and Jabalpur epochs.

Cutch and Jabalpur.—Jabalpur beds are found in Central India to the south of the Nerbudda Valley, and form the highest true Gondwána beds. The Cutch beds, as already mentioned, are found interstratified with marine deposits of uppermost Jurassic age far to the westward, a little east of the mouths of the River Indus. The similarity of the plant-remains in the two series has caused them to be classed together, but it is not certain that they are really of contemporaneous origin.

The following is a list of the Jabalpur plants (*Pal. Ind.* ser. xi. pt. 2) :—

CONIFERÆ.—*Palissya*, 2 sp.; *Araucarites*, 1; *Echinostrobus*, 2; *Brachyphyllum*, 1; *Taxites*, 1; *Gingko*, 1; *Phœnicopsis*, 1; *Czekanowskia*, 1.
CYCADEACEÆ.—*Pterophyllum*, 1; *Ptilophyllum*, 2; *Podozamites*, 3; *Otozamites*, 4; *Williamsonia*, 1; *Cycadites*, 1.
FILICES.—*Sphenopteris*, 1; *Dicksonia*, 1; *Alethopteris*, 3; *Macrotæniopteris*, 1; *Glossopteris*, 1; *Sagenopteris*, 1.

Of these thirty species nine are regarded either as identical with forms found in the Middle Jurassic (Lower Oolitic) of England, or as closely allied.

The Cutch plants belong to the following genera (*Pal. Ind.* ser. xi. pt. 1) :—

CONIFERÆ.—*Palissya*, 3 sp.; *Pachyphyllum*, 1; *Echinostrobus*, 1; *Araucarites*, 1.
CYCADEACEÆ.—*Ptilophyllum*, 3; *Otozamites*, 3; *Cycadites*, 1; *Williamsonia*, 1; *Cycadolepis*, 1.
FILICES.—*Oleandridium*, 1; *Tæniopteris*, 1; *Alethopteris*, 1; *Pecopteris*, 1; *Pachypteris*, 2; *Actinopteris*, 1.

Of the twenty-two species enumerated, four are identified with specific forms found in the Middle Jurassic of Yorkshire, and seven others are closely allied. The Cutch and Jabalpur beds, in short, are intimately related with European fossil floras, whilst the associations of Indian fossil plants found in the Rájmahál, Damuda, and Karharbári beds have no such close connection with Western types.

One interesting fact should be mentioned. The Cutch flora occurs in the upper part of the Umia beds, the lower beds of which contain *Cephalopoda* of Portlandian and Tithonian forms. In a lower subdivision of the Cutch Jurassic rocks, the Katrol group, shown by numerous Ammonites to be allied to Kimmeridge and upper Oxford beds of Western Europe, four species of plants have been found, of which three are met with in the Umia beds, and the fourth, an English Oolitic form, in the Jabalpur series. This evidence seems in favour of the view that the flora underwent change more slowly than the marine fauna.

It will be as well, before leaving the subject of the Gondwána groups, to show in a tabular form the geological age assigned to the flora and fauna of each separately, on the evidence afforded

[1] *Q. J. G. S.* 1869, pp. 138, 152, &c.; 1875, p. 427; *Pal. Ind.* ser. iv. pt. 2; *Man. Geol. Ind.* p. 151.

by comparison with the plants and animals known from European formations.

		Plants	Animals
Upper Gondwána	Cutch	Middle Jurassic.	Uppermost Jurassic ? Neocomian (marine)
	Jabalpur	Middle Jurassic.	—
	Kota	—	Lower Jurassic (Liassic)
	Maleri	Middle or Lower Jurassic	Triassic
Lower Gondwána	Rájmahál	Rhætic	—
	Panchet	Rhætic	Triassic or Permian
	Damuda	Middle Jurassic.	Middle Jurassic
	Karharbári, Talchir	Lower Triassic	—

Flora of Tonquin.—Quite recently M. Zeiller has described a series of plants from some coal-bearing beds in Tonquin (*Bull. Soc. Géol.* ser. iii. vol. xi. p. 456). This flora is very extraordinary in every respect. It consists of twenty-two species, and contains only two peculiar forms; ten, or nearly one-half, are European species found in the Lower Lias or Rhætic; whilst of the remaining ten, five are Damuda forms *Noeggerathiopsis hislopi, Macrotæniopteris feddeni, Palæovittaria kurzi, Glossopteris browniana*, and *Phyllotheca indica*, one species being common to the Newcastle beds and Carboniferous flora of Australia, and two others closely allied to the forms there occurring. The other five are said to be Rájmahál forms, four *Tæniopteris* or *Angiopteridium* and an *Otozamites*. M. Zeiller unhesitatingly classes the Tonquin beds as Rhætic. It is most singular that these coal-beds, although more distant from Europe by 18° of longitude than either the Damuda or Rájmahál beds of India, contain a larger proportion of European fossil species than any known Indian plant-beds; whilst the association in the same strata of upper and lower Gondwána forms, if well ascertained, shows how hopeless is the attempt to classify these deposits by plant evidence alone.

Australian Coal-Measures and Associated Beds.—In the notice of the lower Gondwána floras of India it was observed that there was a great resemblance between some of them and those found in certain beds of Australia. These latter present even a more remarkable instance of homotaxial perversity than do the Indian rocks. The Australian plant-bearing beds are found in Eastern and Southern Australia, Queensland, and Tasmania. For a knowledge of the geology of the country we are chiefly indebted to the writings of the late Mr. Clarke,[1] whilst the flora has been worked out by McCoy, Dana, Carruthers, and Feistmantel, the latter having recently published a much more complete account than was previously available (*Palæontographica.—Pal. u. mes. Flora des östl. Australien*, 1878–79).

The following are the fresh-water or subaërial beds of Australia, according to the latest classification:—

6. Clarence River beds, New South Wales (Mesozoic carbonaceous of Queensland, Victoria, and Tasmania).
5. Wianamatta beds, N.S. Wales.
4. Hawkesbury beds, N. S. Wales (Bacchus Marsh sandstones, Victoria).
3. Newcastle beds, N.S. Wales.
2. Lower Coal-Measures with marine layers interstratified, N.S. Wales.
1. Lower Carboniferous beds, N.S. Wales.

To a still lower horizon probably belong some beds in Queensland, containing *Lepidodendron nothum* and *Cyclostigma*. They are considered Devonian by Carruthers, and there are some ancient plant-beds in Victoria that may be of the same period.

1. *Lower Carboniferous Beds.*—These underlie the beds with a Carboniferous marine fauna. The localities given are Smith's Creek, near Stroud, Port Stephens, and Arowa. The following plants are enumerated:—

LYCOPODIACEÆ.—*Cyclostigma*, 1 sp.; *Lepidodendron*, 2 or 3; *Knorria*, 1.
FILICES.—*Rhacopteris*, 4; *Archæopteris*, 2 (?); *Glossopteris*, 1.
EQUISETACEÆ.—*Calamites*, 2; *Sphenophyllum*, 1.

This flora contains several species identical with those in the Lower Carboniferous (Bernician) of Europe, corresponding to the mountain limestone. The agreement both in homotaxis and position is the more remarkable because of the startling contrast in the next stage. The only peculiarity is the presence of a *Glossopteris*. This comes from a different locality—Arowa—from most of the fossils, and the species is identical with one found in a much higher series. Under these circumstances it is impossible to feel satisfied that the specimen was really from this horizon. The evidence is not so clear as is desirable.

2. *Lower Coal Measures with Marine Beds.*—The following plants are recorded:—

CYCADEACEÆ.—*Noeggerathiopsis*, 1 sp.
FILICES.—*Glossopteris*, 4.
EQUISETACEÆ.—*Annularia*, 1; *Phyllotheca*, 1.

In the marine beds, which are interstratified, are found Lower Carboniferous (mountain limestone) marine fossils in abundance, such as *Orthoceras, Spirifer, Fenestella, Conularia*, &c. The plants belong to forms declared to be typically Jurassic by palæontologists. As the interstratification of the marine and plant-bearing beds has been repeatedly questioned by palæontologists, it is necessary to point out that the geological evidence brought forward by Mr. Clarke is of the clearest and most convincing character, that this evidence has been confirmed by all the geologists who are acquainted with the country, and has only been doubted by those who have never been near the place.

3. *Newcastle Beds.*—By all previous observers in the field these had been united to the preceding and the flora declared to be the same. Dr. Feistmantel has, however, pointed out important differences. Unfortunately, as he has been unable to examine the beds, it still remains uncertain whether the distinction, which has been overlooked by all the field geologists, is quite so great as it appears from the list of fossils given. The following is the flora:—

CONIFERÆ.—*Brachyphyllum*, 1 sp.
CYCADEACEÆ.—*Zeugophyllites*, 1; *Noeggerathiopsis*, 3.
FILICES.—*Sphenopteris*, 4; *Glossopteris*, 8; *Gangamopteris*, 2; *Caulopteris* (?), 1.
EQUISETACEÆ.—*Phyllotheca*, 1; *Vertebraria*, 1.

The only animal known from the beds is a heterocercal ganoid fish, *Urosthenes australis*, a form with Upper Palæozoic affinities.

It will be noticed that the difference from the flora of the underlying beds associated with marine strata is chiefly specific, and by no means indicative of great difference of age, though the only species considered as common to the two by Dr. Feistmantel is *Glossopteris browniana*, found also in the Damuda series of India, in Tonquin, and in South Africa.

The plant fossils of the Newcastle beds and of the underlying series with marine fossils are those which exhibit so remarkable a similarity to the flora of the Indian lower Gondwánas, and especially to the Damudas. The same genera of plants, especially *Noeggerathiopsis, Glossopteris, Phyllotheca, Vertebraria*, prevail in both. But the lower beds of Australia, to judge by the marine fauna, are of Lower Carboniferous age, and it is impossible to suppose that the Newcastle beds are of very much later date. They are said to be comformable to the lower beds with marine fossils, and even to pass into them, and they should probably, if the lower beds are Lower Carboniferous, be classed as Middle or Upper Carboniferous. Thus if the evidence of marine faunas be accepted as decisive, the Damuda beds of India are homotaxially related to Jurassic strata in Europe and to Carboniferous in Australia.

But the Australian Newcastle flora has been quite as positively classed as Jurassic by European palæobotanists as that of the Damudas. It would be easy to quote a long list of authorities—McCoy, De Zigno, Saporta, Schimper, Carruthers, and others—in support of the Jurassic age of the Australian beds. For years the testimony of Australian geologists was rejected, and doubts thrown upon their observations. There is, so far as I know, no case in the whole history of palæontology in which the conflict of palæontological evidence has been so remarkably displayed.

4. *Hawkesbury Beds.*—The fauna and flora are poor. Only two fish, *Clithrolepis granulatus* and *Myriolepis clarkei*, and one plant, *Thinnfeldia odontopteroides*, are known, and of the three forms two recur in the Wianamatta beds.

An important character of the Hawkesbury beds, to which further reference will be made presently, is the occurrence of transported boulders (Wilkinson, quoted by Feistmantel, *Rec. Geol. Surv. Ind.* 1880, p. 257), apparently brought thither by the action of ice.

Similar boulders have been observed in certain sandstones in

[1] *Q. J. G. S.* 1861, p. 354, and *Remarks on the Sedimentary Formations of New South Wales*, 1878, besides numerous other works.

Victoria known as the Bacchus Marsh beds. From these beds two species of *Gangamopteris* have been described by McCoy. *Gangamopteris*, it should be recollected, is a genus of ferns closely allied to *Glossopteris*, and abundant in the Damuda and still more so in the Karharbári beds of the lower Gondwánas in India.

5. *Wianamatta Beds.*—These are the highest portion of the whole system in New South Wales. They contain the following organic remains:—

ANIMALS.

PISCES.—*Palæoniscus antipodeus, Clithrolepis granulatus.*

PLANTS.

FILICES.—*Thinnfeldia* (*Pecopteris*) *odontopteroides, Odontopteris microphylla, Pecopteris tenuifolia, Tæniopteris wianamattæ.*

EQUISETACEÆ.—*Phyllotheca hookeri.*

The fish from the Wianamatta, Hawkesbury, and Newcastle beds, four in number, were considered as a whole by Sir P. Egerton to be most nearly allied to the Permian fauna of Europe.

The Wianamatta plants, like those in the lower beds, are classed as Jurassic.

6. *Higher Mesozoic Beds.*—These, which do not appear to have been traced into connection with the Wianamatta and Hawkesbury beds, occur in widely separated localities, from Queensland to Tasmania. The correlation of these widely scattered deposits, and the assignment of them collectively to a position above that of the Wianamatta beds, appear solely founded upon the fossil flora, and it would be satisfactory to have in addition some geological evidence or some palæontological data derived from marine fossils. The Queensland flora is said to occur in beds overlying marine strata of Middle Jurassic age.

The following plants are recorded from these higher beds:—

CYCADEACEÆ.—*Zamites* (*Podozamites*), 3 sp.; *Otozamites*, 1.
FILICES.—*Sphenopteris*, 1; *Thinnfeldia*, 1; *Cyclopteris*, 1; *Alethopteris*, 1; *Tæniopteris*, 1; *Sagenopteris*, 1.
EQUISETACEÆ.—*Phyllotheca*, 1.

Tabulating, as in the case of the Indian Gondwána system, the age of the different Australian subdivisions as determined by their fossil plants and animals on purely palæontological grounds, we have the following result:—

	Plants	Animals
6. Higher Mesozoic beds	Jurassic	Jurassic (marine)
5. Wianamatta beds	Jurassic	Permian
4. Hawkesbury beds	Jurassic	Permian
3. Newcastle beds	Jurassic	Permian
2. Lower Coal-Measures	Jurassic	Lower Carboniferous (marine)
1. Lower Carboniferous beds	Lower Carboniferous	—

South Africa.—In connection with the later Palæozoic and older Mesozoic rocks of Australia and India, it is of importance to mention briefly the corresponding fresh-water or subaërial formations of Southern Africa, although in that country there are not such marked discrepancies in the palæontological evidence, perhaps because the relations of the beds with remains of animals to the plant-bearing strata are less clearly known. It will be sufficient to notice some of the most prominent peculiarities of these formations here, as I hope that a fuller account will be given to the section by Prof. Rupert Jones, who has made an especial study of South African geology.

In the interior of South Africa, occupying an immense tract in the northern parts of Cape Colony, the Orange Free State, Transvaal, and the deserts to the westward of the last two, there is a great system of sandstone and shales with some coal-beds generally known as the Karoo formation. The sequence of subdivisions is the following (*Q. J. G. S.* xxiii. 1867, p. 142):—

Stormberg beds, about	1800	feet	thick		
Beaufort	,,	,,	1700	,,	,,
Koonap	,,	,,	1500	,,	,,

The beds are but little disturbed in general, and form great plateaux. They rest partly on Palæozoic rocks (Carboniferous or Devonian), partly on gneissic formations. As in Australia, the underlying Palæozoic rocks contain a flora allied to the Carboniferous flora of Europe.

At the base of the Karoo formation are certain shales with coal, known as the Ecca beds, and remarkable for containing a great boulder-bed, the Ecca or Dwyka conglomerate (Sutherland, *Q. J. G. S.* xxvi. p. 514), like that in the Tálchir beds in India and the Hawkesbury sandstone in Australia, the boulders, precisely as in the Tálchir beds, being embedded in fine compact silt or sandstone, which in both countries has been mistaken for a volcanic rock. The Ecca beds are said to contain *Glossopteris* and some other plants, but the accounts are as yet somewhat imperfect. The whole Karoo system, according to the latest accounts, rests unconformably on the Ecca beds, whilst the Ecca beds are conformable to the underlying Palæozoic strata.

Unfortunately, although a considerable number of animals and a few plants have been described from the "Karoo formation," it is but rarely that the precise subdivision from which the remains were brought has been clearly known.

The known species of plants are very few in number: *Glossopteris browniana*, and two other species of *Glossopteris* (one classed by Tate as *Dictyopteris*, *Q. J. G. S.* xxiii. p. 141) *Rubidgea*, a fern nearly akin to *Gangamopteris* and *Glossopteris*, and a *Phyllotheca*-like stem are recorded, without any certain horizon, but probably from the Beaufort beds. There is no doubt as to the close similarity of these plants to those of the Damudas of India and the Newcastle beds of Australia.

From the Stormberg beds there are reported *Pecopteris* or *Thinnfeldia odontopteroides, Cyclopteris cuneata*, and *Tæniopteris daintreei* (Dunn, "Report on Stormberg Coal-Field," *Geol. Mag.* 1879, p. 552), three of the most characteristic fossils of the uppermost plant-beds in Australia, and all found in the upper Jurassic Queensland beds.

The animals found in the Karoo beds (Owen, "Cat. Foss. Rept. S. Africa, Brit. Mus. 1876," &c.) are more numerous by far than the plants. The greater portion have been secured from the Beaufort beds. They comprise numerous genera of dicynodont, theriodont, and dinosaurian reptiles, two or three genera of labyrinthodont amphibians, some fish allied to *Palæoniscus* and *Amblyplerus*, and one mammal, *Tritylodon*. Of the above the *Tritylodon* and some reptilian and fish remains are said to be from the Stormberg beds.

Tritylodon is most nearly related to a Rhætic European mammal. The relations of the reptiles called *Theriodontia* by Sir R. Owen are not clearly defined, but representatives of them and of the *Dicynodontia* as already noticed are said to be found in the Permian of Russia. The *Glossopteris* and its associates may of course be classed as Carboniferous or Jurassic, according to taste. Neither the fauna nor flora show sufficiently close relations to those of any European beds for any safe conclusions as to age, even if homotaxis and synchronism be considered identical. On the other hand, there are remarkable points of agreement with the faunas and floras of the Indian and Australian rocks.

Away from the typical Karoo area on the coast south of Natal there is found a series of beds, partly marine, sometimes called the Uitenhage (*Q. J. G. S.* xxvii. p. 144) series. A few cycads (*Otozamites, Podozamites, Pterophyllum*), a conifer, and ferns (*Pecopteris* or *Alethopteris, Sphenopteris, Cyclopteris*) are quoted from them, and three or four of the forms are closely allied or identical with species found in the Rájmahál beds of India.

It was at first supposed that the plant-bearing beds were lower in position than those containing marine fossils, and the whole of the Uitenhage series was considered as of later age than the Karoo beds. The marine beds were considered Middle Jurassic. Subsequently, however, Stow (*Q. J. G. S.* xxvii. p. 479) showed conclusively that a portion of the marine beds, judging by their fossils, are of uppermost Jurassic or even Neocomian age, and also that the relation of the plant-bearing beds to the marine strata are far less simple than was supposed (*l.c.* p. 505, 511, 513, &c.). Indeed, to judge from Stow's account, it is by no means clear that a portion of the wood-bed series or saliferous series, to which the plant-beds belong, is not higher in position than the marine Jurassic strata.

There is a very extraordinary similarity between the geology of the southern part of Africa and that of the peninsula of India. In both countries a thick fresh-water formation, without any marine beds intercalated, occupies a large area of the interior of the country, whilst on the coast some marine Jurassic and Cretaceous rocks are found, the former in association with beds containing plants. The coincidence is not even confined to sedimentary beds. As in India so in South Africa, the uppermost inland Mesozoic fresh-water beds are capped by volcanic rocks.

It has been assumed, but not apparently on any clear evidence,

that the marine coast-beds and the associated plant-beds are in Africa much newer than the inland sandstone formation, but it is not impossible that the relations may really be the same as in India, and that the Stormberg beds of the inland formation may be the equivalents of the Upper Jurassic or even the Cretaceous marine beds on the coast. The discovery of plants identical with those of the Jurassic (probably Upper Jurassic) beds of Queensland in the Stormberg series may of course be taken for what it is worth; it is of quite as much importance in indicating the age of the rocks as the occurrence of dicynodont reptiles in the Permian of Russia and in the lower Godwánas of India.

Altogether there is quite sufficient probability that the upper Karoo or Stormberg beds are of later age than Triassic to justify the protest which I made last year against a skull being described from these beds as that of a "Triassic" mammal (*Q. J. G. S.* xl. p. 146). The practice, so common amongst palæontologists, of positively asserting as a known fact the geological age of organisms from beds of which the geological position is not clearly determined is very much to be deprecated.

I have called attention to the occurrence of boulders in the Tálchir beds in India, the Ecca beds of South Africa, and the Bacchus Marsh sandstones and Hawkesbury beds of Australia. The idea has occurred quite independently to several different observers that each of these remarkable formations affords evidence of glacial action; and although, in the case of India especially, the geographical position of the boulder-bed within the tropics seemed for a long time to render the notion of ice action too improbable to be accepted, further evidence has so far confirmed the view as to cause it to be generally received. Even before the Australian boulder-deposits had been observed, it was suggested that the Tálchir beds and Ecca conglomerate might be contemporaneous (*Q. J. G. S.* xxxi. p. 528), and that the evidence in favour of a Glacial epoch having left its traces in the Permian beds of England (*Q. J. G. S.* xi. p. 185) might possibly indicate that the Indian and South African boulder-beds are of the same geological epoch. The discovery of two similar deposits in Australia adds to the probability that all may have resulted from the same cause and may record contemporaneous phenomena. It would be very unwise to insist too much on the coincidence.

It would be easy to call attention to further examples of discrepancies in palæontological evidence, but I should weary you and nothing would be attained by going through instance after instance of deposits in distant parts of the world, the age of which has been solely determined by the examination of a few fossil forms of land and fresh-water animals and plants. I have, therefore, only taken a few with the details of which I have had occasion to become acquainted. In some of the most important cases I have mentioned, such as those of the Pikermi and Siwalik faunas, the Cutch (Umia beds) flora, and that in the lower Coal-Measures of Australia, the conflict is between the evidence of the marine and terrestrial organisms. Manifestly one or the other of these leads to erroneous conclusions.

The general opinion of geologists is in favour of accepting the evidence of marine organisms. The reason is not far to seek. So far as I am aware no case is known where such an anomaly as that displayed in the Gondwánas of India has been detected amongst marine formations of which the sequence was unquestioned. In the Gondwánas we have a Rhætic flora overlying a Jurassic flora, and a Triassic fauna above both. In Australia we find a Jurassic flora associated with a Carboniferous marine fauna, and overlaid by a Permian fresh-water fauna. The only similar case amongst marine strata is that of the well-known colonies of the late M. Barrande in Bohemia, and in this instance the intercalation of strata containing later forms amongst beds with older types is disputed, whilst the difference in age between the faunas represented is not to be compared to that between Triassic and Jurassic.

There is, however, another and an even stronger reason for accepting the evidence of marine instead of that afforded by terrestrial and fresh-water animals and plants. If we compare the distribution of the two at the present day, we shall find a very striking difference, and it is possible that this difference may afford a clue to the conditions that prevailed in past times.

Wanderers into what they fancy unexplored tracts in palæontology are very likely to find Prof. Huxley's footprints on the path they are following. I have had occasion to turn to a paper of his on *Hyperodopedon* (*Q. J. G. S.* xxv. p. 150), that very curious reptile already mentioned, of which the remains occur both in Great Britain and in India, and I find the following remarks, which appear so exactly to express a portion of the view to which I wish to call your attention, that I trust I may be excused for quoting them. Prof. Huxley writes:—

"It does not appear to me that there is any necessary relation between the fauna of a given land and that of the seas of its shores. The land-faunæ of Britain and Japan are wonderfully similar; their marine faunæ are in several ways different. Identical marine shells are collected on the Mozambique coast and in the easternmost islands of the Pacific; whilst the faunæ of the lands which lie within the same range of longitude are extraordinarily different. What now happens geographically to provinces in space is good evidence as to what, in former times, may have happened to provinces in time; and an essentially identical land-fauna may have been contemporary with several successive marine faunæ.

"At present our knowledge of the terrestrial faunæ of past epochs is so slight that no practical difficulty arises from using, as we do, sea-reckoning for land-time. But I think it highly probable that sooner or later the inhabitants of the land will be found to have a history of their own."

When these words were written more than twenty-four years ago, scarcely one of the geological details to which I have called your attention was known. I need not point out how wonderful a commentary such details have afforded to Prof. Huxley's views.

I have no desire to quote authority. I fear that in the facts I have been laying before you my quotations of the most authoritative writers have been made less for the purpose of showing reverence than of expressing scepticism. My reason for calling attention to Prof. Huxley's views is different. I entirely agree with them; but there is, I think, something to be added to them. There is, I believe, an additional distinction between land and marine faunas that requires notice, and this distinction is one of very great importance and interest. It appears to me that at the present day the difference between the land-faunas of different parts of the world is so vastly greater than that between the marine faunas that, if both were found fossilised, whilst there would be but little difficulty in recognising different marine deposits as of like age from their organic remains, terrestrial and fresh-water beds would in all probability be referred to widely differing epochs, and that some would be more probably classed with those of a past period than with others of the present time.

I had proposed to enter at some length into this subject, and to attempt a sketch of the present state of our knowledge concerning the distribution of terrestrial and marine faunas and floras. But I found that it was impossible to do justice to the question without making this address far longer than is desirable, and I have already taken up more time than I ought to have done. I can therefore only treat the subjects very briefly.

As you are doubtless aware, the most important work upon the distribution of terrestrial animals yet published is that of Mr. Wallace. He divides the earth's surface into six regions—Palæarctic, Ethiopian, Oriental, Australian, Neotropical, and Nearctic. Some naturalists, with whom I am disposed to agree, consider Madagascar and the adjacent islands a seventh region, and it is possible that one or two other additions might be made.

These regions are essentially founded on the distribution of *Vertebrata*, especially mammals and birds, and the following table, taken from Wallace's lists, shows the percentage of peculiar families of Vertebrata and peculiar genera of Mammalia in each region, Mammalia being selected as being more characteristic than birds, and better known than reptiles, amphibians, or fishes:—

Regions	Total Families of Vertebrates	Peculiar Families	Percentage of Peculiar Families	Total Genera of Mammals	Peculiar Genera of Mammals	Percentage of Peculiar Genera
Palæarctic	137	3	2·2	100	37	37
Ethiopian	175	23	13·1	142	90	63
Oriental	163	12	7·4	118	54	46
Australian	142	30	21·1	70	45	65
Neotropical	168	45	26·8	131	103	79
Nearctic	121	12	9·9	74	24	32

The marine mammals and reptiles are too few in number to

be compared with the land-fauna, but whales, porpoises, seals, sirenians, turtles, and sea-snakes are for the most part widely diffused. The best class of the Vertebrata for comparison is that of the fishes, and some details taken by Wallace from Günther's "British Museum Catalogue" are very important. The whole class is divided into 116 families, of which 29 are exclusively confined to fresh water, whilst 80 are typically marine. Of these 80 no less than 50 are universally, or almost universally, distributed, whilst many others have a very wide range. Four families are confined to the Atlantic and 13 to the Pacific Ocean, whilst a few more are exclusively southern or northern. About 63 are found in both the Atlantic and Pacific.

Now, of the 29 fresh-water families, 15, or more than one-half, are confined each to a single region, 9 are found each in two regions, 2 in three regions, and the same number in four; one only (*Cyprinidæ*) is found in five regions, whilst not one is met with in all six. It is impossible to conceive a greater contrast: 50 marine families, or 62·5 per cent., have a world-wide distribution, whilst not a single fresh-water family has an equally extended range, and more than one-half are confined each to a single region.

The regions adopted by Wallace, as already stated, are founded on the *Vertebrata*; he considers, however, that the distribution of the invertebrates is similar. So far as the terrestrial Mollusca are concerned, I am inclined to dissent from this view. But for one circumstance, the Mollusca would afford an admirable test of the theory that marine types—species, genera, and families—are much more widely spread than terrestrial. I am assured that this is the case, but the difficulty of proving it arises from the fact that the classification of pulmonate terrestrial Mollusca, as adopted by naturalists generally, is so artificial as to be worthless. Genera like *Helix*, *Bulimus*, *Achatina*, *Pupa*, *Vitrina*, as usually adopted, are not real genera, but associations of species united by characters of no systematic importance, and the attempts that have hitherto been made at a natural classification have chiefly been founded on the shells, the animals not being sufficiently known for their affinities, in a very large number of cases, to be accurately determined. Of late years, however, more attention has been devoted to the soft parts of land mollusks, and in Dr. Paul Fischer's "Manuel de Conchyliologie" now being published, a classification of the Pulmonate Gasteropoda is given, which, although still imperfect for want of additional information, is a great improvement upon any previously available. In this work the first 13 families of the *Pulmonata Geophila* comprise all the non-operculate land Mollusca, or snails and slugs, and these 13 families contain 82 genera thus distributed:—

Peculiar to one of Wallace's land regions . . .	54
Found in more than one, but not in both America and the Eastern Hemisphere	12
Common to both hemispheres	16

The last 16, however, include *Limax*, *Vitrina*, *Helix*, *Pupa*, *Vertigo*, and some other genera which certainly need further repartition. The operculated land-shells belonging to a distinct sub-order, or order, and closely allied to the ordinary Prosobranchiate Gasteropoda, are better classified, the shells in their case affording good characters. They comprise four well-marked families (*Helicinidæ*, *Cyclostomidæ*, *Cyclophoridæ*, and *Diplommatinidæ*), besides others less well marked or but doubtfully terrestrial. Not one of the families named is generally distributed, and the genera are for the most part restricted to one or two regions. The portion of Dr. Fischer's manual relating to these Mollusca is unpublished, and the latest general account available is that of Pfeiffer, published in 1876 (*Monographia Pneumonopomorum Viventium, Supp.* iii.). From this monograph I take the following details of distribution. The number of genera enumerated is 64 (including *Proserpinidæ*).

Peculiar to one of Wallace's land regions . . .	48
Found in more than one, but not in both America and the Eastern Hemisphere	8
Common to both hemispheres	8

It is the distribution of the terrestrial operculate Mollusca which induces me to suspect that the distribution of land Mollusca differs from that of land vertebrates. One instance I may give. There is nowhere a better-marked limit to two vertebrate faunas than that known as Wallace's line separating the Australian and Oriental regions, and running through the Malay peninsula between Java, Sumatra, and Borneo on the one hand, and Papua with the neighbouring groups on the other. There is in the two regions a very great difference in the vertebrate genera, and a considerable replacement of families. The Oriental *Vertebrata* contain far more genera and families common to Africa than to Australia. Now, the operculate land-shells known from New Guinea and Northern Australia belong to such genera as *Cyclophorus*, *Cyclotus*, *Leptopoma*, *Pupinella*, *Pupina*, *Diplommatina*, and *Helicina*, all found in the Oriental region, and mostly characteristic of it, whilst the only peculiar types known are *Leucoptychia*, closely allied to *Leptopoma*, from New Guinea, and *Heterocyclus*, apparently related to the Indian *Cyathopoma*, from New Caledonia. Farther east, in Polynesia, there are some very remarkable and peculiar types of land-shells, such as *Achatinella*, but these do not extend to Australia or Papua. On the other hand, scarcely a single Oriental genus extends to Africa, the terrestrial molluscan fauna of which continent differs far more from that of the Oriental region than the latter does from that of tropical Australia.

The same is the case with plants. In an important work lately published by Dr. O. Drude of Dresden, the tropics of the Old World are divided into three distinct regions—(1) tropical Africa; (2) the East African islands, Madagascar, &c.; (3) India, South-Eastern Asia, the Malay Archipelago, Northern Australia, and Polynesia.

A very large proportion of the families and even of the genera of marine Mollusca are almost of world-wide distribution, and even of the tropical and sub-tropical genera the majority are found in all the warmer seas. I have no recent details for the whole of the marine Mollusca, but a very fair comparison with the data already given for land-shells may be obtained from the first twenty-five families of Prosobranchiate Gasteropoda, all that are hitherto published in Fischer's manual. These twenty-five families include *Conidæ*, *Olividæ*, *Volutidæ*, *Buccinidæ*, *Muricidæ*, *Cypreidæ*, *Strombidæ*, *Cerithiidæ*, *Planaxidæ*, and their allies, and contain 116 living marine genera, the known range of which is the following:—

Found only in the Atlantic Ocean	15	
Found only in the Pacific or Indian Ocean, or both	28	
Found only in Arctic or Antarctic Seas, or in both	12	
		—55
Found in the warmer parts of all oceans . . .	34	
Widely, and for the most part universally, distributed	27	
		—61

That is, 52·6 per cent. are found in both hemispheres, whilst only 19·5 per cent. of the inoperculate, and 12·5 per cent. of the operculate land Mollusca, have a similar distribution. This is, however, only an imperfect test of the difference, which is really much greater than these numbers named imply by themselves.

Some genera of fresh-water Mollusca, as *Unio*, *Anodon*, *Cyclas*, *Lymnea*, *Planorbis*, *Paludina*, and *Bythinia*, are very widely spread, but a much larger number are restricted. Thus, if *Unio* and *Anodon* are extensively distributed, all allied fresh-water genera, like *Monocondylæa*, *Mycetopus*, *Iridina*, *Spatha*, *Castalia*, *Ætheria*, and *Mülleria*, inhabit one or two regions at the most. The same result is not found from taking an equally important group of marine Mollusca, such as *Veneridæ* or *Cardiadæ*.

Throughout the marine Invertebrata, so far as I know, the same rule holds good: a few generic types are restricted to particular seas; the majority are found in suitable habitats throughout a large portion of the globe. The marine provinces that have been hitherto distinguished, as may be seen by referring to those in Woodward's "Manual of the Mollusca," or Forbes and Godwin-Austen's "Natural History of the European Seas," or Fischer's "Manuel de Conchyliologie," or Agassiz' "Revision of the Echini," are founded on specific distinctions, whilst the terrestrial regions are based on generic differences, and often on the presence or absence of even larger groups than genera.

Botany offers a still more remarkable example. I have just referred to Dr. Oscar Drude's work (*Petermann's Mittheilungen*, Ergänzungsheft, No. 74, "Die Florenreiche der Erde"), published within the last few months, on the distribution of plants. Dr. Drude divides the surface of the globe into four groups of floral regions (*Florenreichsgruppe*), and these again into floral regions (*Florenreiche*), fifteen in number, which are again divided into sub-regions (*Gebiete*). The first group of floral regions is the oceanic, comprising all the marine vegetation of the world;

and so uniform is this throughout that no separate regions can be established, so that there is but one oceanic to contrast with fourteen terrestrial regions.

It is impossible to enter further into this subject now, and I can only allude to the evidence in favour of the existence of land-regions in past times. It is scarcely necessary to remind you of the proofs already accumulated of differences between the fauna of distant countries in Tertiary times. The Eocene, Miocene, and Pliocene Vertebrata of North America differ quite as much from those of Europe in the same periods as do the genera of the present day; and there was as much distinction between the Mammalia of the Himalayas and of Greece when the Siwalik and Pikermi faunas were living as there is now. In Mesozoic times we have similar evidence. The reptiles of the American Jurassic deposits present wide differences from those of the European beds of that age, and the South African reptilian types of the Karoo beds are barely represented elsewhere. But there is no reason for supposing that the limits or relations of the zoological and botanical regions in past times were the same as they now are. It is quite certain indeed that the distribution of land-areas, whether the great oceanic tract has remained unchanged in its general outlines or not, has undergone enormous variations, and the migration of the terrestrial fauna and flora must have been dependent upon the presence or absence of land communication between different continental tracts; in other words, the terrestrial regions of past epochs, although just as clearly marked as those of the present day, were very differently distributed. The remarkable resemblance of the floras in the Karoo beds of South Africa, the Damuda of India, and the Coal-Measures of Australia, and the wide difference of all from any European fossil flora, is a good example of the former distribution of life; whilst it is scarcely necessary to observe that the present Neotropical and Australian mammals resemble those of the same countries in the later Tertiary times much more than they do the living Mammalia of other regions, and that the Australian mammal fauna is in all probability more nearly allied to the forms of life inhabiting Europe in the Mesozoic era than to any European types of later date. If the existing mammals of Australia had all become extinct, a deposit containing their bones would probably have been classed as Mesozoic.

The belief in the former universality of faunas and floras is very much connected with the idea once generally prevalent, and still far from obsolete, that the temperature of the earth's surface was formerly uniform, and that at all events until early or even Middle Tertiary times the Poles were as warm as the Equator, and both enjoyed a constant tropical climate. The want of glacial evidence from past times in Spitzbergen and Greenland, where a temperature capable of supporting arboreal vegetation has certainly prevailed during several geological periods, is counterbalanced by the gradually accumulating proofs of Lower Mesozoic or Upper Palæozoic Glacial epochs in South Africa, Australia, and, strangest of all, in India. Even during those periods of the earth's history where there is reason to believe that the temperature in high latitudes was higher than it now is, evidence of distinct zones of climate has been observed, and quite recently Dr. Neumayr,[1] of Vienna, has shown that the distribution of Cretaceous and Jurassic *Cephalopoda* throughout the earth's surface proves that during those periods the warmer and cooler zones of the world existed in the same manner as at present, and that they affected the distribution of marine life as they do now.

The idea that marine and terrestrial faunas and floras were similar throughout the world's surface in past times is so ingrained in palæontological science that it will require many years yet before the fallacy of the assumption is generally admitted. No circumstance has contributed more widely to the belief than the supposed universal diffusion of the Carboniferous flora. The evidence that the plants which prevailed in the Coal-Measures of Europe were replaced by totally different forms in Australia, despite the closest similarity in the marine inhabitants of the two areas at the period, will probably go far to give the death-blow to an hypothesis that rests upon no solid ground of observation. In a vast number of instances it has been assumed that similarity between fossil terrestrial faunas and floras proves identity of geological age, and, by arguing in a vicious circle, the occurrence of similar types assumed without sufficient proof to belong to the same geological period has been alleged as evidence of the existence of similar forms in distant countries at the same time.

In the preceding remarks it may perhaps have surprised some of my auditory that I have scarcely alluded to any American formations, and especially that I have not mentioned so well-known and interesting a case of conflicting palæontological evidence as that of the Laramie group. My reason is simply that there are probably many here who are personally acquainted with the geology of the American Cretaceous and Tertiary beds, and who are far better able to judge than I am of the evidence as a whole. To all who are studying such questions in America I think it will be more useful to give the details of similar geological puzzles from the Eastern Hemisphere than to attempt an imperfect analysis of difficult problems in the great Western continent.

Perhaps it may be useful, considering the length to which this address has extended, to recapitulate the principal facts I have endeavoured to bring before you. These are—

1. That the geological age assigned on homotaxial grounds to the Pikermi and Siwalik mammalian faunas is inconsistent with the evidence afforded by the associated marine deposits.

2. The age similarly assigned on the same data to the different series of the Gondwána system of India is a mass of contradictions: beds with a Triassic fauna overlying others with Rhætic or Jurassic floras.

3. The geological position assigned on similar evidence to certain Australian beds is equally contradictory, a Jurassic flora being of the same age as a Carboniferous marine fauna.

4. The same is probably the case with the terrestrial and fresh-water faunas and floras of South Africa.

5. In instances of conflicting evidence between terrestrial or fresh-water faunas and floras on one side, and marine faunas on the other, the geological age indicated by the latter is probably correct, because the contradictions which prevail between the evidence afforded by successive terrestrial and fresh-water beds are unknown in marine deposits, because the succession of terrestrial animals and plants in time has been different from the succession of marine life, and because in all past times the differences between the faunas and floras of distant lands have probably been, as they now are, vastly greater than the differences between the animals and plants inhabiting the different seas and oceans.

6. The geological age attributed to fossil terrestrial faunas and floras in distant countries on account of the relations of such faunas and floras to those found in European beds has proved erroneous in so large a number of cases that no similar determinations should be accepted unless accompanied by evidence from marine beds. It is probable in many cases—perhaps in the majority—where the age of beds has been determined solely by the comparison of land or fresh-water animals or plants with those found in distant parts of the globe, that such determinations are incorrect.

SECTION H

ANTHROPOLOGY

Opening Address by Edward B. Tylor, D.C.L., F.R.S., President of the Section

Our newly-constituted Section of Anthropology, now promoted from the lower rank of a Department of Biology, holds its first meeting under remarkable circumstances. Here in America one of the great problems of race and civilisation comes into closer view than in Europe. In England anthropologists infer from stone arrow-heads and hatchet-blades, laid up in burial-mounds or scattered over the sites of vanished villages, that Stone Age tribes once dwelt in the land; but what they were like in feature and complexion, what languages they spoke, what social laws and religion they lived under, are questions where speculation has but little guidance from fact. It is very different when under our feet in Montreal are found relics of a people who formerly dwelt here, Stone Age people, as their implements show, though not unskilled in barbaric arts, as is seen by the ornamentation of their earthen pots and tobacco-pipes, made familiar by the publications of Principal Dawson. As we all know, the record of Jacques Cartier, published in the sixteenth century collection of Ramusio, proves by text and drawing that here stood the famous palisaded town of Hochelaga. Its inhabitants, as his vocabulary shows, belonged to the group of tribes whose word for 5 is *wisk*—that is to say, they were of

[1] "Ueber klimatische Zonen während der Juras und Kreidezeit," *Denkschr. Math. Nat. Cl. Akad. Wiss. Wien*, vol. xlvii. 1883.

the Iroquois stock. Much as Canada has changed since then, we can still study among the settled Iroquois the type of a race lately in the Stone Age, still trace remnants and records of their peculiar social institutions, and still hear spoken their language of strange vocabulary and unfamiliar structure. Peculiar importance is given to Canadian anthropology by the presence of such local American types of man, representatives of a stage of culture long passed away in Europe. Nor does this by any means oust from the Canadian mind the interest of the ordinary problems of European anthropology. The complex succession of races which make up the pedigree of the modern Englishman and Frenchman, where the descendants perhaps of palæolithic, and certainly of neolithic, man have blended with invading Keltic, Roman, Teutonic-Scandinavian peoples—all this is the inheritance of settlers in America as much as of their kinsfolk who have stayed in Europe. In the present scientific visit of the Old to the New World, I propose to touch on some prominent questions of anthropology with special reference to their American aspects. Inasmuch as in an introductory address the practice of the Association tends to make arguments unanswerable, it will be desirable for me to suggest rather than dogmatise, leaving the detailed treatment of the topics raised to come in the more specialised papers and discussions which form the current business of the Section.

The term *prehistoric*, invaluable to anthropologists since Prof. Daniel Wilson introduced it more than thirty years ago, stretches back from times just outside the range of written history into the remotest ages where human remains or relics, or other more indirect evidence, justifies the opinion that man existed. Far back in these prehistoric periods, the problem of Quaternary man turns on the presence of his rude stone implements in the drift gravels and in caves, associated with the remains of what may be called for shortness the mammoth-fauna. Not to recapitulate details which have been set down in a hundred books, the point to be insisted on is how, in the experience of those who, like myself, have followed them since the time of Boucher de Perthes, the effect of a quarter of a century's research and criticism has been to give Quaternary man a more and more real position. The clumsy flint pick and its contemporary mammoth-tooth have become stock articles in museums, and every year adds new localities where palæolithic implements are found of the types catalogued years ago by Evans, and in beds agreeing with the sections drawn years ago by Prestwich. It is generally admitted that about the close of the Glacial period savage man killed the huge maned elephants, or fled from the great lions and tigers, on what was then forest-clad valley-bottom, in ages before the later waterflow had cut out the present wide valleys 50 or 100 feet or more lower, leaving the remains of the ancient drift-beds exposed high on what are now the slopes. To fix our ideas on the picture of an actual locality, we may fancy ourselves standing with Mr. Spurrell on the old sandy beach of the Thames near Crayford, 35 feet above where the river now flows two miles away in the valley. Here we are on the very workshop-floor where palæolithic man sat chipping at the blocks of flint which had fallen out of the chalk cliff above his head. There lie the broken remains of his blocks, the flint chips he knocked off, and which can be fitted back into their places, the striking-stones with which the flaking was done; and with these the splintered bones of mammoth and tichorhine rhinoceros, possibly remains of meals. Moreover, as if to point the contrast between the rude palæolithic man who worked these coarse blocks, and apparently never troubled himself to seek for better material, the modern visitor sees within fifty yards of the spot the bottle-shaped pits dug out in later ages by neolithic man through the soil to a depth in the chalk where a layer of good workable flint supplied him with the material for his neat flakes and trimly-chipped arrow-heads. The evidence of caverns such as those of Devonshire and Perigord, with their revelations of early European life and art, has been supplemented by many new explorations, without shaking the conclusion arrived at as to the age known as the reindeer period of the northern half of Europe, when the mammoth and cave-bear and their contemporary mammals had not yet disappeared, but the close of the Glacial period was merging into the times when in England and France savages hunted the reindeer for food as the Arctic tribes of America do still. Human remains of these early periods are still scarce and unsatisfactory for determining race-types. Among the latest finds is part of a skull from the loess, at Podbaba, near Prague, with prominent brow-ridges, though less remarkable in this way than the celebrated Neanderthal skull. It remains the prevailing opinion of anatomists that these very ancient skulls are not apt to show extreme lowness of type, but to be higher in the scale than, for instance, the Tasmanian. The evidence increases as to the wide range of palæolithic man. He extended far into Asia, where his characteristic rude stone implements are plentifully found in the caves of Syria and the foot-hills of Madras. The question which this Section may have especial means of dealing with is whether man likewise inhabited America with the great extinct animals of the Quaternary period, if not even earlier.

Among the statements brought forward as to this subject, a few are mere fictions, while others, though entirely genuine, are surrounded with doubts, making it difficult to use them for anthropological purposes. We shall not discuss the sandalled human giants, whose footprints, 20 inches long, are declared to have been found with the footprints of mammoths, among whom they walked, at Carson, Nevada. There is something picturesque in the idea of a man in a past geological period finding on the Pampas the body of a glyptodon, scooping out its flesh, setting up its carapace on the ground like a monstrous dish-cover, and digging himself a burrow to live in underneath this animal roof; but geologists have not accepted the account. Even in the case of so well-known an explorer as the late Dr. Lund, opinions are still divided as to whether his human skulls from the caves of Brazil are really contemporary with the bones of megatherium and the fossil horse. One of the latest judgments has been favourable: Quatrefages not only looks upon the cave-skulls as of high antiquity, but regards their owners as representing the ancestors of the living Indians. The high and narrow dimensions of the ancient and modern skulls are given in the "Crania Ethnica," and whatever a similarity of proportions between them may prove, it certainly exists. Dr. Koch's celebrated flint arrow-head, recorded to have been found under the leg-bones of a mastodon in Missouri, is still to be seen, and has all the appearance of a modern Indian weapon, which raises doubt of its being really of the mastodon period. This antecedent improbability of remote geological age is felt still more strongly to attach to the stone pestles and mortars, &c., brought forward by Mr. J. D. Whitney, of the California Geological Survey, as found by miners in the gold-bearing gravels. On the one hand, these elaborate articles of stone-work are the very characteristic objects of the Indian graves of the district, and on the other the theory that the auriferous gravels capped by lava-flows are of Tertiary age is absolutely denied by geologists such as M. Jules Marcou in his article on "The Geology of California" (*Bull. Soc. Géol. de France*, 1883). It is to be hoped that the Section may have the opportunity of discussing Dr. C. C. Abbott's implements from Trenton, New Jersey. The turtle-back celts, as they are called from their flat and convex sides, are rudely chipped from pebbles of the hard argillite out of the boulder-bed, but the question is as to the position of the sand and gravel in which they are found in the bluffs high above the present Delaware River. The first opinion come to, that the makers of the implements inhabited America not merely after but during the great Ice Age, has been modified by further examination, especially by the report of Mr. H. Carvill Lewis, who considers the implement-bearing bed not to have been deposited by a river which flowed over the top of the boulder-bed, but that, at a later period than this would involve, the Delaware had cut a channel through the boulder-bed, and that a subsequent glacier-flood threw down sand and gravel in this cutting at a considerable height above the existing river, burying therein the rude stone implements of an Esquimaux race then inhabiting the country. Belt, Wilson, and Putnam have written on this question, which I will not pursue further, except by pointing out that the evidence from the bluffs of the Delaware must not be taken by itself, but in connection with that from the terraces high above the James River, near Richmond, where Mr. C. M. Wallace has likewise reported the finding of rude stone instruments, to which must be added other finds from Guanajuato, Rio Juchipila, and other Mexican localities.

This leads at once into the interesting argument how far any existing people are the descendants and representatives of man of the Post-Glacial period. The problem whether the present Esquimaux are such a remnant of an early race is one which Prof. Boyd Dawkins has long worked at, and will, I trust, bring forward with full detail in this appropriate place. Since he stated this view in his work on "Cave-Hunting," it has continually been cited, whether by way of affirmation or denial, but always with that gain to the subject which arises from a theory based on distinct facts. May I take occasion here to mention

as preliminary the question, Were the natives met with by the Scandinavian seafarers of the eleventh century Esquimaux, and whereabouts on the coast were they actually found? It may be to Canadians a curious subject of contemplation how about that time of history Scandinavia stretched out its hands at once to their old and their new home. When the race of bold sea-rovers who ruled Normandy and invaded England turned their prows into the northern and western sea, they passed from Iceland to yet more inclement Greenland, and thence, according to Icelandic records, which are too consistent to be refused belief as to main facts, they sailed some way down the American coast. But where are we to look for the most southerly points which the Sagas mention as reached in Vineland? Where was Keelness, where Thorvald's ship ran aground, and Cross-ness, where he was buried, when he died by the *skräling's* arrow? Rafn, in the "Antiquitates Americanæ," confidently maps out these places about the promontory of Cape Cod, in Massachusetts, and this has been repeated since from book to book. I must plead guilty to having cited Rafn's map before now, but when with reference to the present meeting I consulted our learned editor of Scandinavian records at Oxford, Mr. Gudbrand Vigfusson, and afterwards went through the original passages in the Sagas with Mr. York Powell, I am bound to say that the voyages of the Northmen ought to be reduced to more moderate limits. It appears that they crossed from Greenland to Labrador (Helluland), and thence sailing more or less south and west, in two stretches of two days each they came to a place near where wild grapes grew, whence they called the country Vineland. This would, therefore, seem to have been somewhere about the Gulf of St. Lawrence, and it would be an interesting object for a yachting cruise to try down from the east coast of Labrador a fair four days' sail of a Viking ship, and identify, if possible, the sound between the island and the ness, the river running out of the lake into the sea, the long stretches of sand, and the other local features mentioned in the Sagas. While this is in the printers' hands, I hear that a paper somewhat to this same effect may come before the Geographical Section, but the matter concerns us here as bearing on the southern limit of the Esquimaux. The *skrälings* who came on the sea in skin canoes (*hudhkeipr*), and hurled their spears with slings (*valslöngva*), seem by these very facts to have been probably Esquimaux, and the mention of their being swarthy, with great eyes and broad cheeks, agrees tolerably with this. The statement usually made that the word *skräling* meant "dwarf" would, if correct, have settled the question; but, unfortunately, there is no real warrant for this etymology. If we may take it that Esquimaux 800 years ago, before they had ever found their way to Greenland, were hunting seals on the coast of Newfoundland, and cariboo in the forest, their life need not have been very unlike what it is now in their Arctic home. Some day, perhaps, the St. Lawrence and Newfoundland shores will be searched for relics of Esquimaux life, as has been done with such success in the Aleutian Islands by Mr. W. H. Dall, though on this side of the continent we can hardly expect to find, as he does, traces of long residence, and rise from a still lower condition.

Surveying now the vast series of so-called native, or indigenous, tribes of North and South America, we may admit that the fundamental notion on which American anthropology has to be treated is its relation to Asiatic. This kind of research is, as we know, quite old, but the recent advances of zoology and geology have given it new breadth as well as facility. The theories which account for the wide-lying American tribes, disconnected by language as they are, as all descended from ancestors who came by sea in boats, or across Behring's Straits on the ice, may be felt somewhat to strain the probabilities of migration, and are likely to be remodelled under the information now supplied by geology as to the distribution of animals. It has become a familiar fact that the Equidæ, or horse-like animals, belong even more remarkably to the New than to the Old World. There was plainly land-connection between America and Asia for the horses whose remains are fossil in America to have been genetically connected with the horses re-introduced from Europe. The deer may have passed from the Old World into North America in the Pliocene period; and the opinion is strongly held that the camels came the other way, originating in America and spreading thence into Asia and Africa. The mammoth and the reindeer did not cross over a few thousand years ago by Behring's Straits, for they had been since Pleistocene times spread over the north of what was then one continent. To realise this ancient land-junction of Asia and America, this "Tertiary-bridge," to use Prof. Marsh's expression, it is instructive to look at Mr. Wallace's chart of the present soundings, observing that an elevation of under 200 feet would make Behring's Straits land, while moderately shallow sea extends southward to about the line of the Aleutian Islands, below which comes the plunge into the ocean depths. If, then, we are to consider America as having received its human population by ordinary migration of successive tribes along this highway, the importance is obvious of deciding how old man is in America, and how long the continent remained united with Asia, as well as how these two difficult questions are bound up together in their bearing on anthropology. Leaving them to be settled by more competent judges, I will only point out that the theory of northern migration on dry land is after all only a revival of an old opinion which came naturally to Acosta in the sixteenth century, because Behring's Straits were not yet known of, and was held by Buffon in the eighteenth, because the zoological conditions compelled him to suppose that Behring's Straits had not always been there. Such a theory, whatever the exact shape it may take, seems wanted for the explanation of that most obvious fact of anthropology, the analogy of the indigenes of America with Asiatics, and more especially with East and North Asiatics or Mongoloids. This broad race-generalisation has thrust itself on every observer, and each has an instance to mention. My own particular instance is derived from inspection of a party of Botocudo Indians lately exhibited in London, who in proper clothing could have passed without question as Thibetans or Siamese. Now when ethnologists like Dr. Pickering remark on the South Asiatic appearance of Californian tribes, it is open to them to argue that Japanese sailors of junks wrecked on the coast may have founded families there. But the Botocudos are far south and on the other side of the Andes, rude dwellers in the forests of Brazil, and yet they exhibit in an extreme form the Mongoloid character which makes America to the anthropologist part and parcel of Asia. Looked at in this light, there is something suggestive in our still giving to the natives of America the name of Indians; the idea of Columbus that the Caribs were Asiatics was not so absurd after all.

It is perhaps hardly needful now to protest against stretching the generalisation of American uniformity too far, and taking literally Humboldt's saying that he who has seen one American has seen all. The common character of American tribes, from Hudson's Bay to Tierra del Fuego, though more homogeneous than on any other tract of the world of similar extent, admits of wide subvariation. How to distinguish and measure this subvariation is a problem in which anthropology has only reached unsatisfactory results. The broad distinctions which are plainly seen are also those which are readily defined, such as the shape of the nose, curve of the lips, or the projection of the cheek-bones. But all who have compared such American races as Aztecs and Ojibwas must be sensible of extreme difficulty in measuring the proportions of an average facial type. The attempt to give in a single pair of portraits a generalised national type has been tried—for instance, in the St. Petersburg set of models of races at the Exhibition of 1862. But done merely by eye, as they were, they were not so good as well-chosen individual portraits. It would be most desirable that Mr. Francis Galton's method of photographs superposed so as to combine a group of individuals into one generalised portrait, should have a thorough trial on groups of Iroquois, Aztecs, Caribs, and other tribes who are so far homogeneous in feature as to lend themselves to form an abstract portrait. A set of American races thus "Galtonised" (if I may coin the term) would very likely be so distinctive as to be accepted in anthropology. Craniological measurement has been largely applied in America, but unfortunately it was set wrong for years by the same misleading tendency to find a uniformity not really existent. Those who wish to judge Morton's dictum applied to the Scioto Mound skull, "the perfect type of Indian conformation, to which the skulls of all the tribes from Cape Horn to Canada more or less approximate," will find facts to the contrary set forth in Chap. XX. of Wilson's "Prehistoric Man," and in Quatrefages and Hamy, "Crania Ethnica." American crania really differ so much that the hypothesis of successive migrations has been brought in to account for the brachycephalic skulls of the mound-builders as compared with living Indians of the district. Among minor race-divisions, as one of the best established may be mentioned that which in this district brings the Algonquin and Iroquois together into the dolichocephalic division;

yet even here some divide the Algonquins into two groups by their varying breadth of skull. What may be the interpretation of the cranial evidence as bearing on the American problem it would be premature to say; at present all that can be done is to systematise facts. It is undisputed that the Esquimaux in their complexion, hair, and features approximate to the Mongoloid type of North Asia; but when it comes to cranial measurement the Esquimaux, with their narrower skulls, whose proportion of breadth to length is only 75 to 80, are far from conforming to the broad-skulled type of North Asiatic Mongoloids, whose average index is toward 85. Of this divergence I have no explanation to offer; it illustrates the difficulties which have to be met by a young and imperfect science.

To clear the obscurity of race-problems, as viewed from the anatomical standing point, we naturally seek the help of language. Of late years the anthropology of the Old World has had ever-increasing help from comparative philology. In such investigations, when the philologist seeks a connection between the languages of distant regions, he endeavours to establish both a common stock of words and a common grammatical structure. For instance, this most perfect proof of connection has been lately adduced by Mr. R. H. Codrington in support of the view that the Melanesians and Polynesians, much as they differ in skin and hair, speak languages which belong to a common stock. A more adventurous theory is that of Lenormant and Sayce, that the old Chaldean language is connected with the Tatar group; yet even here there is an *a priori* case based at once on analogies of dictionary and grammar. The comparative method becomes much weaker when few or no words can be claimed as similar, and the whole burden of proof has to be borne by similar modes of word-formation and syntax, as, for example, in the researches of Aymonier and Keane tending to trace the Malay group of languages into connection with the Khmer or Cambodian. Within America the philologist uses with success the strong method of combined dictionary and grammar in order to define his great language-groups, such as the Algonquin, extending from Hudson's Bay to Virginia, the Athabascan, from Hudson's Bay to New Mexico, both crossing Canada in their vast range. But attempts to trace analogies between lists of words in Asiatic and American languages, though they may have shown some similarities deserving further inquiry, have hardly proved an amount of correspondence beyond what chance coincidence would be capable of producing. Thus when it comes to judging of affinities between the great American language-families, or of any of them, with the Asiatic, there is only the weaker method of structure to fall back on. Here the Esquimaux analogy seems to be with North Asiatic languages. It would be defined as agglutinative-suffixing, or, to put the definition practically, an Esquimaux word of however portentous length, is treated by looking out in the dictionary the first syllable or two, which will be the root, the rest being a string of modifying suffixes. The Esquimaux thus presents in an exaggerated form the characteristic structure of the vast Ural-Altaic or Turanian group of Asiatic languages. In studying American languages as a whole, the first step is to discard the generalisation of Duponceau as to the American languages from Greenland to Cape Horn being united together, and distinguished from those of other parts of the world by a common character of polysynthetism, or combining whole sentences into words. The real divergences of structure in American language-families are brought clearly into view in the two dissertations of M. Lucien Adam, which are the most valuable papers of the Congrès International des Americanistes. Making special examination of sixteen languages of North and South America, Adam considers these to belong to a number of independent or irreducible families, as they would have been, he says, "had there been primitively several human couples." It may be worth suggesting, however, that the task of the philologer is to exhaust every possibility of discovering connections between languages before falling back on the extreme hypothesis of independent origins. These American language-families have grammatical tendencies in common, which suggest original relationship, and in some of these even correspond with languages of other regions in a way which may indicate connection rather than chance. For instance, the distinction of gender, not by sex as male and female, but by life as animate and inanimate, is familiar in the Algonquin group; in Cree *muskesin* = shoe (mocassin) makes its plural *muskesinŭ*, while *eskwayū* = woman (squaw) makes its plural *eskwaywuk*. Now, this kind of gender is not peculiar to America, but appears in South-East Asia, as for instance in the Kol languages of Bengal. In that Asiatic district also appears the habit of infixing, that is, of modifying roots or words by the insertion of a letter or syllable, somewhat as the Dakota language inserts a pronoun within the verb-root itself, or as that remarkable language, the Chocta, alters its verbs by insertions of a still more violent character. Again, the distinction between the inclusive and exclusive pronoun *we*, according as it means "You and I" or "they and I," &c. (the want of which is perhaps a defect in English), is as familiar to the Maori as to the Ojibwa. Whether the languages of the American tribes be regarded as derived from Asia or as separate developments, their long existence on the American continent seems unquestionable. Had they been the tongues of tribes come within a short time by Behring's Straits, we should have expected them to show clear connection with the tongues of their kindred left behind in Asia, just as the Lapp in Europe, whose ancestors have been separated for thousands of years from the ancestors of the Ostyak or the Turk, still shows in his speech the traces of their remote kinship. The problem how tribes so similar in physical type and culture as the Algonquins, Iroquois, Sioux, and Athabascans, should adjoin one another, yet speaking languages so separate, is only soluble by influences which have had a long period of time to work in.

The comparison of peoples according to their social framework of family and tribe has been assuming more and more importance since it was brought forward by Bachofen, McLennan, and Morgan. One of its broadest distinctions comes into view within the Dominion of Canada. The Esquimaux are patriarchal, the father being head of the family, and descent and inheritance following the male line. But the Indian tribes further south are largely matriarchal, reckoning descent not on the father's but the mother's side. In fact, it was through becoming an adopted Iroquois that Morgan became aware of this system, so foreign to European ideas, and which he supposed at first to be an isolated peculiarity. No less a person than Herodotus had fallen into the same mistake over 2000 years ago, when he thought the Lykians, in taking their names from their mothers, were unlike all other men. It is now, however, an accepted matter of anthropology that in Herodotus's time nations of the civilised world had passed through this matriarchal stage, as appears from the survivals of it retained in the midst of their newer patriarchal institutions. For instance, among the Arabs to this day, strongly patriarchal as their society is in most respects, there survives that most matriarchal idea that one's nearest relative is not one's father but one's maternal uncle; he is bound to his sister's children by a "closer and holier tie" than paternity, as Tacitus says of the same conception among the ancient Germans. Obviously great interest attaches to any accounts of existing tribes which preserve for us the explanation of such social phenomena. Some of the most instructive of these are too new to have yet found their way into our treatises on early institutions; they are accounts lately published by Dutch officials among the non-Islamised clans of Sumatra and Java. G. A. Wilken, "Over de Verwantschap en het Huwelijks en Erfrecht bij de Volken van den Indischen Archipel," summarises the account put on record by Van Hasselt as to the life of the Malays of the Padang Highlands of Mid-Sumatra, who are known to represent an early Malay population. Among these people not only kinship but habitation follows absolutely the female line, so that the numerous dwellers in one great house are all connected by descent from one mother, one generation above another, children, then mothers and maternal uncles and aunts, then grandmothers and maternal great-uncles and great-aunts, &c. There are in each district several *suku* or mother-clans, between persons born in which marriage is forbidden. Here then appear the two well-known rules of female descent and exogamy, but now we come into view of the remarkable state of society that, though marriage exists, it does not form the household. The woman remains in the maternal house she was born in, and the man remains in his; his position is that of an authorised visitor; if he will, he may come over and help her in the rice-field, but he need not; over the children he has no control whatever, and were he to presume to order or chastise them, their natural guardian, the mother's brother (*mamak*), would resent it as an affront. The law of female descent and its connected rules have as yet been mostly studied among the native Americans and Australians, where they have evidently undergone much modification. Thus 150 years ago Father Lafitau mentions that the husband and wife, while in fact moving into one another's hut, or setting up a new one, still kept up the matriarchal idea by the fiction that neither he nor she quitted

their own maternal house. But in the Sumatra district just referred to, the matriarchal system may still be seen in actual existence, in a most extreme and probably early form. If, led by such new evidence, we look at the map of the world from this point of view, there discloses itself a remarkable fact of social geography. It is seen that matriarchal exogamous society, that is, society with female descent and prohibition of marriage within the clan, does not crop up here and there, as if it were an isolated invention, but characterises a whole vast region of the world. If the Malay district be taken as a centre, the system of intermarrying mother-clans may be followed westward into Asia, among the Garos and other hill-tribes of India. Eastward from the Indian Archipelago it pervades the Melanesian islands, with remains in Polynesia; it prevails widely in Australia, and stretches north and south in the Americas. This immense district represents an area of lower culture, where matriarchalism has only in places yielded to the patriarchal system, which develops with the idea of property, and which, in the other and more civilised half of the globe, has carried all before it, only showing in isolated spots and by relics of custom the former existence of matriarchal society. Such a geographical view of the matriarchal region makes intelligible facts which while not thus seen together were most puzzling. When years ago Sir George Grey studied the customs of the Australians, it seemed to him a singular coincidence that a man whose maternal family name was Kangaroo might not marry a woman of the same name, just as if he had been a Huron of the Bear or Turtle totem, prohibited accordingly from taking a wife of the same. But when we have the facts more completely before us, Australia and Canada are seen to be only the far ends of a world-district pervaded by these ideas, and the problem becomes such a one as naturalists are quite accustomed to. Though Montreal and Melbourne are far apart, it may be that in prehistoric times they were both connected with Asia by lines of social institution as real as those which in modern times connect them through Europe. Though it is only of late that this problem of ancient society has received the attention it deserves, it is but fair to mention how long ago its scientific study began in the part of the world where we are assembled. Father Lafitau, whose "Mœurs des Sauvages Amériquains" was published in 1724, carefully describes among the Iroquois and Hurons the system of kinship to which Morgan has since given the name of "classificatory," where the mother's sisters are reckoned as mothers, and so on. It is remarkable to find this acute Jesuit missionary already pointing out how the idea of the husband being an intruder in his wife's house bears on the pretence of surreptitiousness in marriage among the Spartans. He even rationally interprets in this way a custom which to us seems fantastic, but which is a most serious observance among rude tribes widely spread over the world. A usual form of this custom is that the husband and his parents-in-law, especially his mother-in-law, consider it shameful to speak to or look at one another, hiding themselves or getting out of the way, at least in pretence, if they meet. The comic absurdity of these scenes, such as Tanner describes among the Assiniboins, disappears if they are to be understood as a legal ceremony, implying that the husband has nothing to do with his wife's family. To this part of the world also belongs a word which has been more effective than any treatise in bringing the matriarchal system of society into notice. This is the term *totem*, introduced by Schoolcraft to describe the mother-clans of the Algonquins, named "Wolf," "Bear," &c. Unluckily the word is wrongly made. Prof. Max Müller has lately called attention to the remark of the Canadian philologist Father Cuoq (N. O. Ancien Missionnaire), that the word is properly *ote*, meaning "family mark," possessive *otem*, and with the personal pronoun *nind otem*, "my family mark," *kit otem*, "thy family mark." It may be seen in Schoolcraft's own sketch of Algonquin grammar how he erroneously made from these a word *totem*, and the question ought perhaps to be gone into in this Section, whether the term had best be kept up or amended, or a new term substituted. It is quite worth while to discuss the name, considering what an important question of anthropology is involved in the institution it expresses. In this region there were found Iroquois, Algonquins, Dakotas, separate in language, and yet whose social life was regulated by the matriarchal totem structure. May it not be inferred from such a state of things that social institutions form a deeper-lying element in man than language or even physical race-type? This is a problem which presents itself for serious discussion when the evidence can be brought more completely together.

It is obvious that in this speculation, as in other problems now presenting themselves in anthropology, the question of the antiquity of man lies at the basis. Of late no great progress has been made toward fixing a scale of calculation of the human period, but the arguments as to time required for alterations in valley-levels, changes of fauna, evolution of races, languages, and culture, seem to converge more conclusively than ever toward a human period short indeed as a fraction of geological time, but long as compared with historical or chronological time. While, however, it is felt that length of time need not debar the anthropologist from hypotheses of development and migration, there is more caution as to assumptions of millions of years where no arithmetical basis exists, and less tendency to treat everything prehistoric as necessarily of extreme antiquity, such as, for instance, the Swiss lake-dwellings and the Central American temples. There are certain problems of American anthropology which are not the less interesting for involving no considerations of high antiquity; indeed they have the advantage of being within the check of history, though not themselves belonging to it.

Humboldt's argument as to traces of Asiatic influence in Mexico is one of these. The four ages in the Aztec picture-writings, ending with catastrophes of the four elements, earth, fire, air, water, compared by him with the same scheme among the Banyans of Surat, is a strong piece of evidence which would become yet stronger if the Hindoo book could be found from which the account is declared to have been taken. Not less cogent is his comparison of the zodiacs or calendar-cycles of Mexico and Central America with those of Eastern Asia, such as that by which the Japanese reckon the Sixty-year cycle by combining the elements seriatim with the twelve animals, Mouse, Bull, Tiger, Hare, &c.; the present year is, I suppose, the second water-ape year, and the time of day is the goat-hour. Humboldt's case may be reinforced by the consideration of the magical employment of these zodiacs in the Old and New World. The description of a Mexican astrologer, sent for to make the arrangements for a marriage by comparing the zodiac animals of the birthdays of bride and bridegroom, might have been written almost exactly of the modern Kalmuks; and in fact it seems connected in origin with similar rules in our own books of astrology. Magic is of great value in thus tracing communication, direct or indirect, between distant nations. The power of lasting and travelling which it possesses may be instanced by the rock-pictures from the sacred Roches Percées of Manitoba, sketched by Dr. Dawson, and published in his father's volume on "Fossil Man," with the proper caution that the pictures, or some of them, may be modern. Besides the rude pictures of deer and Indians and their huts, one sees with surprise a pentagram more neatly drawn than that defective one which let Mephistopheles pass Faust's threshold, though it kept the demon in when he had got there. Whether the Indians of Manitoba learnt the magic figure from the white man, or whether the white man did it himself in jest, it proves a line of intercourse stretching back 2500 years to the time when it was first drawn as a geometrical diagram of the school of Pythagoras. To return to Humboldt's argument, if there was communication from Asia to Mexico before the Spanish Conquest, it ought to have brought other things, and no things travel more easily than games. I noticed some years ago that the Aztecs are described by the old Spanish writers as playing a game called *patolli*, where they moved stones on the squares of a cross-shaped mat, according to the throws of beans marked on one side. The description minutely corresponds with the Hindoo game of *pachisi*, played in like manner with cowries instead of beans; this game, which is an early variety of backgammon, is well known in Asia, whence it seems to have found its way into America. From Mexico it passed into Sonora and Zacatecas, much broken down, but retaining its name, and it may be traced still further into the game of plum-stones among the Iroquois and other tribes. Now, if the probability be granted that these various American notions came from Asia, their importation would not have to do with any remotely ancient connection between the two continents. The Hindoo element-catastrophes, the East Asiatic zodiac-calendars, the game of backgammon, seem none of them extremely old, and it may not be a thousand years since they reached America. These are cases in which we may reasonably suppose communication by seafarers, perhaps even in some of those junks which are brought across so often by the ocean-current and wrecked on the Californian coast. In connection with ideas borrowed from Asia there arises the question, How did the Mexicans and

Peruvians become possessed of bronze? Seeing how imperfectly it had established itself, not even dispossessing the stone implements, I have long believed it to be an Asiatic importation of no great antiquity, and it is with great satisfaction that I find such an authority on prehistoric archæology as Prof. Worsaae comparing the bronze implements in China and Japan with those of Mexico and Peru, and declaring emphatically his opinion that bronze was a modern novelty introduced into America. While these items of Asiatic culture in America are so localised as to agree best with the hypothesis of communication far south across the Pacific, there are others which agree best with the routes far north. A remarkable piece of evidence pointed out by General Pitt-Rivers is the geographical distribution of the Tatar or composite bow, which in construction is unlike the long-bow, being made of several pieces spliced together, and which is bent backwards to string it. This distinctly Asiatic form may be followed across the region of Behring's Straits into America among the Esquimaux and northern Indians, so that it can hardly be doubted that its coming into America was by a northern line of migration. This important movement in culture may have taken place in remotely ancient times.

A brief account may now be given of the present state of information as to movements of civilisation within the double continent of America. Conspicuous among these is what may be called the northward drift of civilisation which comes well into view in the evidence of botanists as to cultivated plants. Maize, though allied to, and probably genetically connected with, an Old World graminaceous family, is distinctly American, and is believed by De Candolle to have been brought into cultivation in Peru, whence it was carried from tribe to tribe up into the north. To see how closely the two continents are connected in civilisation, one need only look at the distribution on both of maize, tobacco, and cacao. It is admitted as probable that from the Mexican and Central American region agriculture travelled northward, and became established among the native tribes. This direction may be clearly traced in a sketch of their agriculture, such as is given in Mr. Lucien Carr's paper on the "Mounds of the Mississippi Valley." The same staple cultivation passed on from place to place, maize, haricots, pumpkins, for food, and tobacco for luxury. Agriculture among the Indians of the great lakes is plainly seen to have been an imported craft by the way in which it had spread to some tribes but not to others. The distribution of the potter's art is similarly partial, some tribes making good earthen vessels, while others still boiled meat in its own skin with hot stones, so that it may well be supposed that the arts of growing corn and making the earthen pot to boil the hominy came together from the more civilised nations of the south. With this northward drift of civilisation other facts harmonise. The researches of Buschmann, published by the Berlin Academy, show how Aztec words have become embedded in the languages of Sonora, New Mexico, and up the western side of the continent, which could not have spread there without Mexican intercourse extending far north-west. This indeed has left many traces still discernible in the industrial and decorative arts of the Pueblo Indians. Along the courses of this northward drift of culture remain two remarkable series of structures probably connected with it. The Casas Grandes, the fortified communal barracks (if I may so call them) which provided house-room for hundreds of families, excited the astonishment of the early Spanish explorers, but are only beginning to be thoroughly described now that such districts as the Taos Valley have come within reach by the railroads across to the Pacific. The accounts of these village-forts and their inhabitants, drawn up by Major J. W. Powell, of the Bureau of Ethnology, and Mr. Putnam of the Peabody Museum, disclose the old communistic society surviving in modern times, in instructive comment on the philosophers who are seeking to return to it. It would be premature in the present state of information to decide whether Mr. J. L. Morgan, in his work on the "Houses and House-life of the American Aborigines," has realised the conditions of the problem. It is plausible to suppose with him a connection between the communal dwellings of the American Indians, such as the Iroquois long-house with its many family hearths, with the more solid buildings inhabited on a similar social principle by tribes such as the Zuñis of New Mexico. Morgan was so much a man of genius, that his speculations, even when at variance with the general view of the facts, are always suggestive. This is the case with his attempt to account for the organisation of the Aztec State as a highly-developed Indian tribal community, and even to explain the many-roomed stone palaces, as they are called, of Central America, as being huge communal dwellings like those of the Pueblo Indians. I will not go further into the subject here, hoping that it may be debated in the Section by those far better acquainted with the evidence. I need not, for the same reason, do much more than mention the mound-builders, nor enter largely on the literature which has grown up about them since the publication of the works of Squier and Davis. Now that the idea of their being a separate race of high antiquity has died out, and their earthworks with the implements and ornaments found among them are brought into comparison with those of other tribes of the country, they have settled into representatives of one of the most notable stages of the northward drift of culture among the indigenes of America.

Concluding this long survey, we come to the practical question how the stimulus of the present meeting may be used to promote anthropology in Canada. It is not as if the work were new here; indeed some of its best evidence has been gathered on this ground from the days of the French missionaries of the seventeenth century. Naturally, in this part of the country, the rudimentary stages of thought then to be found among the Indians have mostly disappeared. For instance, in the native conceptions of souls and spirits the crudest animistic ideas were in full force. Dreams were looked on as real events, and the phantom of a living or a dead man seen in a dream was considered to be that man's personality and life, that is, his soul. Beyond this, by logical extension of the same train of thought, every animal or plant or object, inasmuch as its phantom could be seen away from its material body in dreams or visions, was held to have a soul. No one ever found this primitive conception in more perfect form than Father Lallemant, who describes, in the "Rélations des Jesuites" (1626), how, when the Indians burried kettles and furs with the dead, the bodies of these things remained, but the souls of them went to the dead men who used them. So Father Le Jeune describes the souls, not only of men and animals, but of hatchets and kettles, crossing the water to the Great Village out in the sunset. The genuineness of this idea of object-souls is proved by other independent explorers finding them elsewhere in the world. Two of the accounts most closely tallying with the American come from the Rev. Dr. Mason, in Burmah, and the Rev. J. Williams, in Fiji. That is to say, the most characteristic development of early animism belongs to the same region as the most characteristic development of matriarchal society, extending from South-East Asia into Melanesia and Polynesia, and North and South America. Every one who studies the history of human thought must see the value of such facts as these, and the importance of gathering them up among the rude tribes who preserve them, before they pass into a new stage of culture. All who have read Mr. Hale's studies on the Hiawatha legend and other Indian folk-lore, must admit that the native traditions, with their fragments of real history, and their incidental touches of native religion, ought never to be left to die out unrecorded. In the Dominion, especially in its outlying districts toward the Arctic region and over the Rocky Mountains, there is an enormous mass of anthropological material of high value to be collected, but this collection must be done within the next generation, or there will be little left to collect. The small group of Canadian anthropologists, able and energetic as they are, can manage and control this work, but cannot do it all themselves. What is wanted is a Canadian Anthropological Society with a stronger organisation than yet exists, able to arrange explorations in promising districts, to circulate questions and requirements among the proper people in the proper places, and to lay a new burden on the shoulders of the already hard-worked professional men and other educated settlers through the newly-opened country, by making them investigators of local anthropology. The Canadian Government, which has well deserved the high reputation it holds throughout the world for wisdom and liberality in dealing with the native tribes, may reasonably be asked to support more thorough exploration, and collection and publication of the results, in friendly rivalry with the United States Government, which has in this way fully acknowledged the obligation of making the colonisation of new lands not only promotive of national wealth but serviceable to science. It is not for me to do more here, and now, than to suggest practical steps towards this end. My laying before the Section so diffusive a sketch of the problems of anthropology as they present themselves in the Dominion has been with the underlying intention of calling public notice to the important scientific work now standing ready to Canadian hands; the undertaking of which it is to be hoped will be one outcome of this visit of the British Association to Montreal.